Tappi

PUBLISHED BY THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

APRIL 1959

VOLUME 42 • NUMBER 4

BOLTON SPECIAL STAINLESS

. . . means more to papermakers than any steel developed in two decades

Its unique properties provide: absolute resistance to corrosion from chemicals normally encountered in refining equipment — protection of the cutting edges against wear and abrasion — toughness to withstand deformation without fracture — and the capacity to resist severe shock.

The need for a metal with this combination of mechanical properties has long been felt. Before the first shipments of Bolton Special Stainless were made in 1948, the choice was between wear resistance or corrosion resistance. Now, The Papermaker gets both, in addition to all other necessary properties.

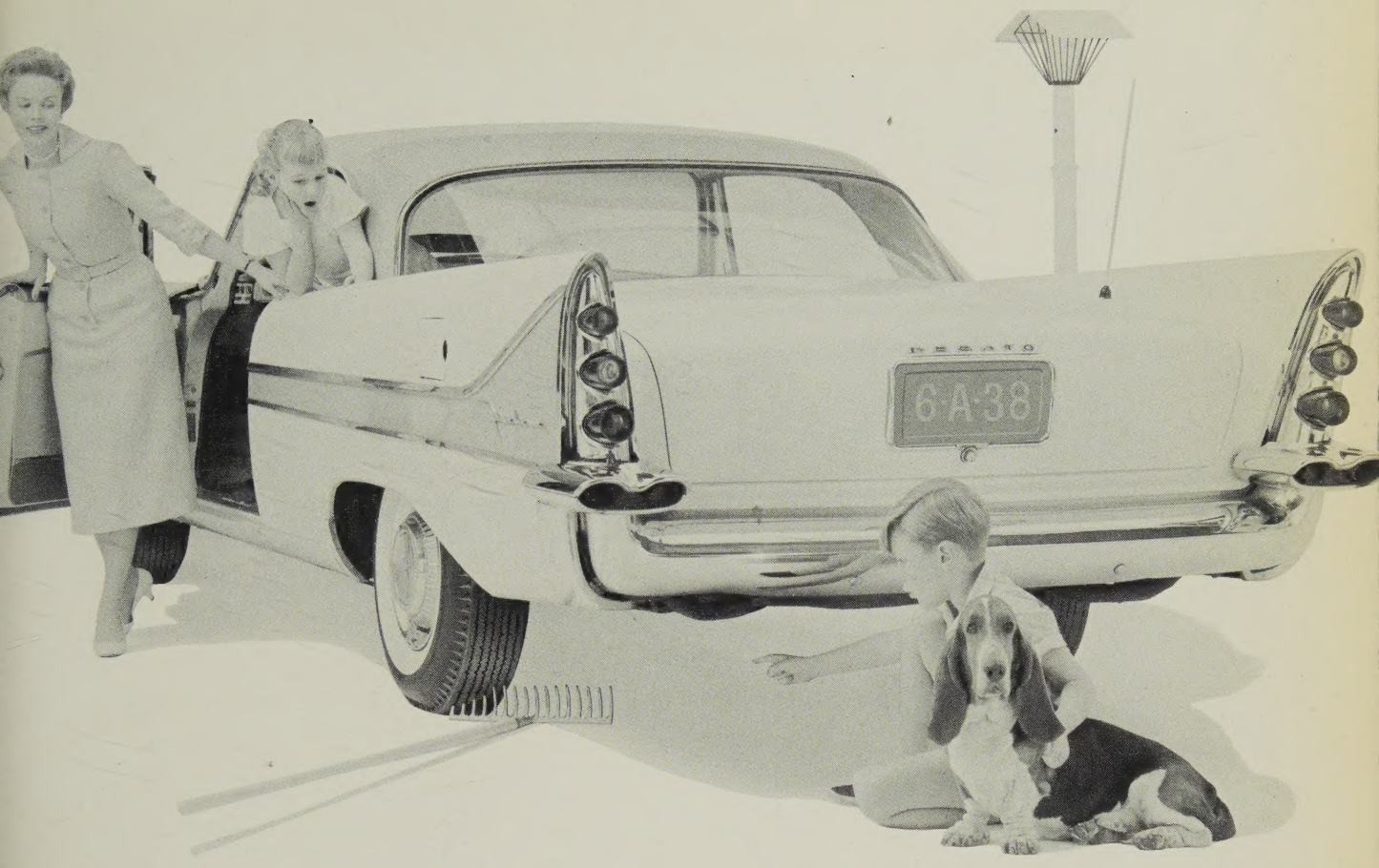
Bolton Special Stainless is a chrome-nickel alloy having a chrome and nickel content approximating that in 300 series Stainless. It has made possible a form of heat-treating never before used commercially on steel for refining equipment. Known as precipitation hardening, this in-plant custom heat-treating gives the finished steel the unique character of being entirely free of stresses. This Bolton heat treatment makes it practicable to control the relationship of mechanical properties of the metal to meet the specialized requirements of paper mill refining operations.

Brinell Hardness	Tensile Strength (Average Minimum)	% Elongation (2")	% Reduction of Area
321	180,200	16.4	74.2
363	199,300	14.5	41.9
415	211,700	14.0	32.1

Various heat treatments for differing mill applications

It has taken years to prove this metal under all operating conditions. Now we have standardized our inventories on Bolton Special Stainless. We are proud to offer this premium quality stainless at no additional cost. Bolton Special Stainless is on hand in quantity to make prompt shipments to the growing number of papermakers *who have compared* — in all patterns, in all makes of Jordans. Don't wait. Try it now. *Call or write John W. Bolton & Sons, Inc., Lawrence, Massachusetts.*

BOLTON EMERSON
TRADE MARK



Courtesy: Seiberling Rubber Company

Alpha® Protein...

for crisp reproduction of a single color half-tone

Visual excitement can be a matter of black and white, as in the picture above where tonal gradations of a single color are vividly produced on paper processed with Alpha Protein.

Coatings made with Alpha Protein insure whiter, more opaque, smoother and more water-resistant printing paper. These qualities improve printability and add brilliance, depth and clarity to reproduction.

If you're not already using Alpha Protein in *your* coating operation you may be passing up an opportunity to cut costs and speed production. Alpha Protein means less drying time, allows faster machine speeds—in many cases has increased production 15 percent! Write or call for complete details.

CENTRAL SOYA COMPANY, INC.

Chemurgy Division

1825 N. Laramie Avenue • Chicago 39, Illinois

This advertisement reproduced on Alpha Protein-processed paper

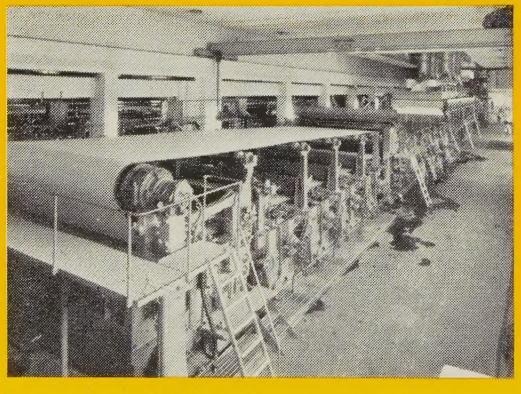
TACRYL®

the fiber for paper maker's felts

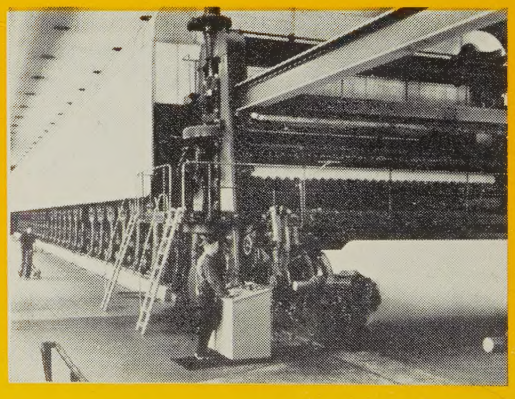
Tacryl for paper maker's felts has proved economically and technically successful. Tacryl endows low-weight bulky felts with high dimensional and dynamic stability. Napping gives a very smooth and durable surface.

TACRYL

- Excellent resistance against deterioration from heat, moisture, acidic hydrolysis, mildew and bacteria.
- Good strength and elasticity even at high temperature and moist conditions combined with high surface friction.
- Low absorbtion by weight of moisture combined with high rate of wetting and good water distribution.



Tacryl felt is used in this modern machine for making cardboard at the Papyrus-plant, one of Sweden's leading paper mills.



Kvarnsveden, Sweden's largest newsprint mill, uses Tacryl felts.

FOSFATBOLAGET

Stockholm 5, Sweden

®

Photo courtesy Endura Corporation, Quakertown, Pennsylvania

Today, the latest is spelled: L-a-t-e-x

It's true! Many of the latest developments in paper are being accomplished through the use of synthetic latex in the form of impregnants, saturants, coatings and adhesives.

Take the kraft paper shown above. It's being saturated with a combination of CHEMIGUM LATEX and PLIOLITE LATEX for ultimate service as top-quality paper tape. The CHEMIGUM LATEX is used to impart toughness, tear resistance, flexibility and good internal bonding. The PLIOLITE LATEX is used as a reinforcing agent to increase tensile, while decreasing elongation and tack. And both exhibit excellent stability and full compatibility with other materials for ease of processing.

In addition to tapes, rubberized or latex-saturated paper finds many other uses—extra-durable book paper, gasketing, industrial wrapping, artificial flowers, simulated leather. Whatever your product, it will pay you to know more about CHEMIGUM LATEX and the other latices in one of the most complete lines currently offered. For full details, including the latest *Tech Book Bulletins*, write to Goodyear, Chemical Division, Dept. D-9432, Akron 16, Ohio.

GOODYEAR

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Chemigum, Plioflex, Pliolite, Pliovic—T. M.'s The Goodyear Tire & Rubber Company, Akron, Ohio

If you're looking for more brightness in filler clays, many paper makers find that SWW is their answer. SWW's GE Brightness is 82-83.5 percent, but it is equivalent in all other physical properties to air-floated filler clays.

SWW is available in lump or pulverized form. It can be shipped bagged via boxcar or truck; bulk in hopper or box cars.

SWW is one of the complete range of filler and coating clays, air-floated and water washed, supplied by Huber to the paper and container industries.

Write for working samples.

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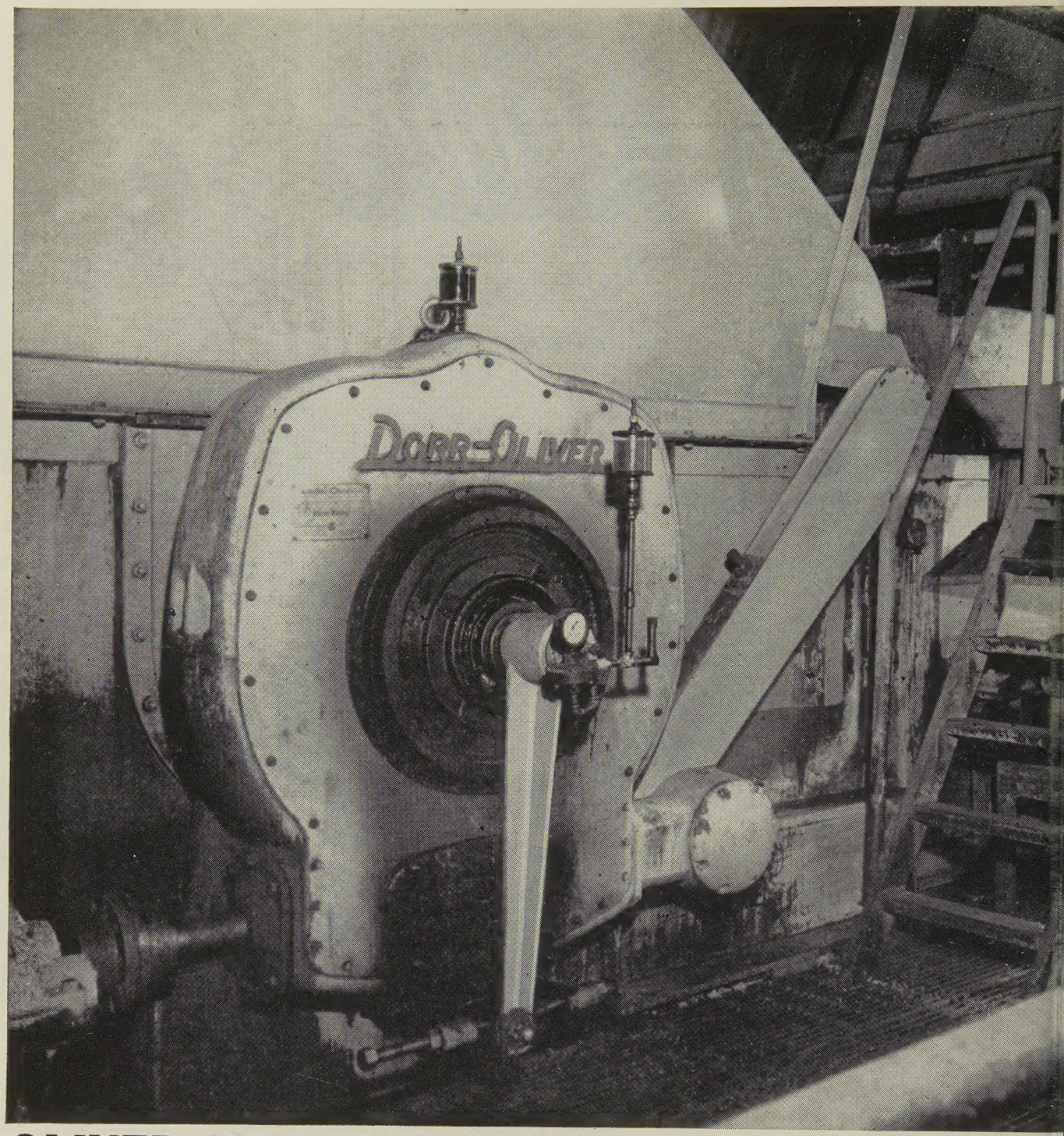


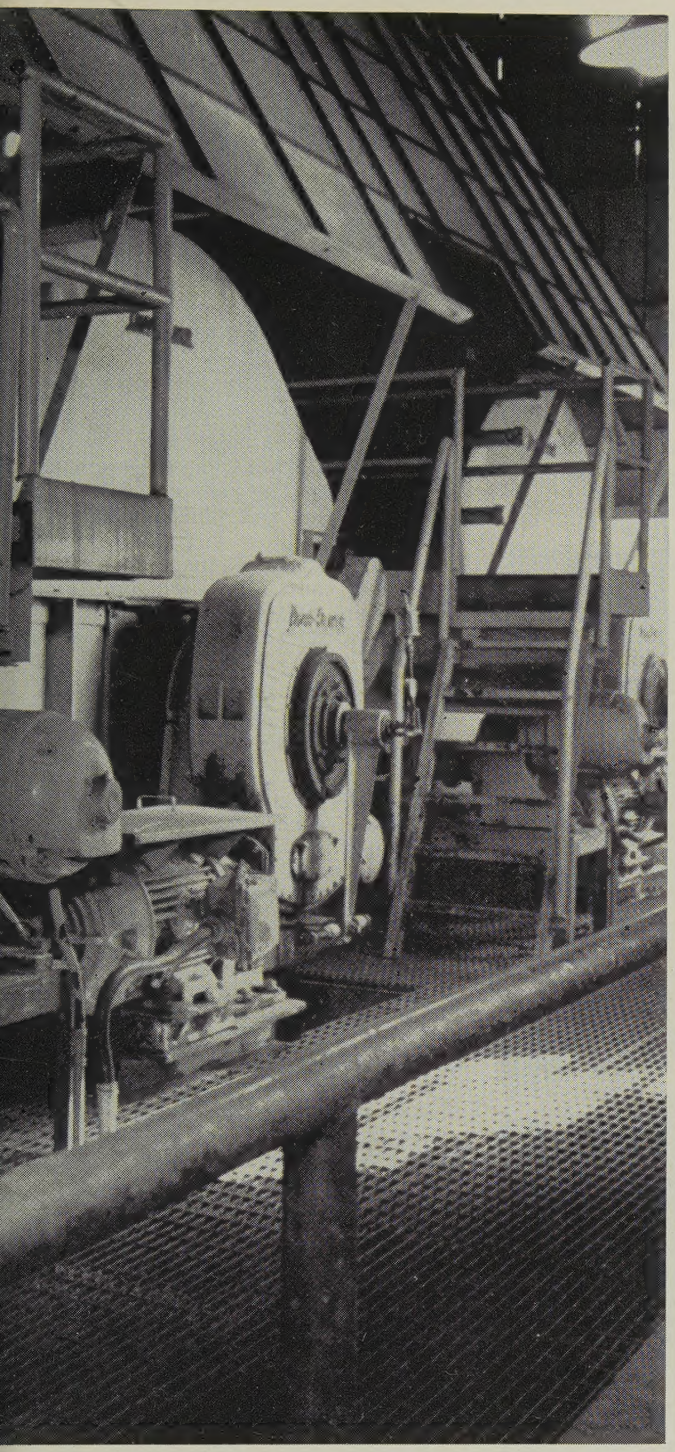
OLIVER BROWNSTOCK WASHING SYSTEM *handles 390 tons per day at the Weyerhaeuser mill, Longview, Washington*

Further evidence of the acceptance of the Oliver Brownstock Washing System is offered by the recent installation at the Longview, Washington mill of the Weyerhaeuser Timber Company.

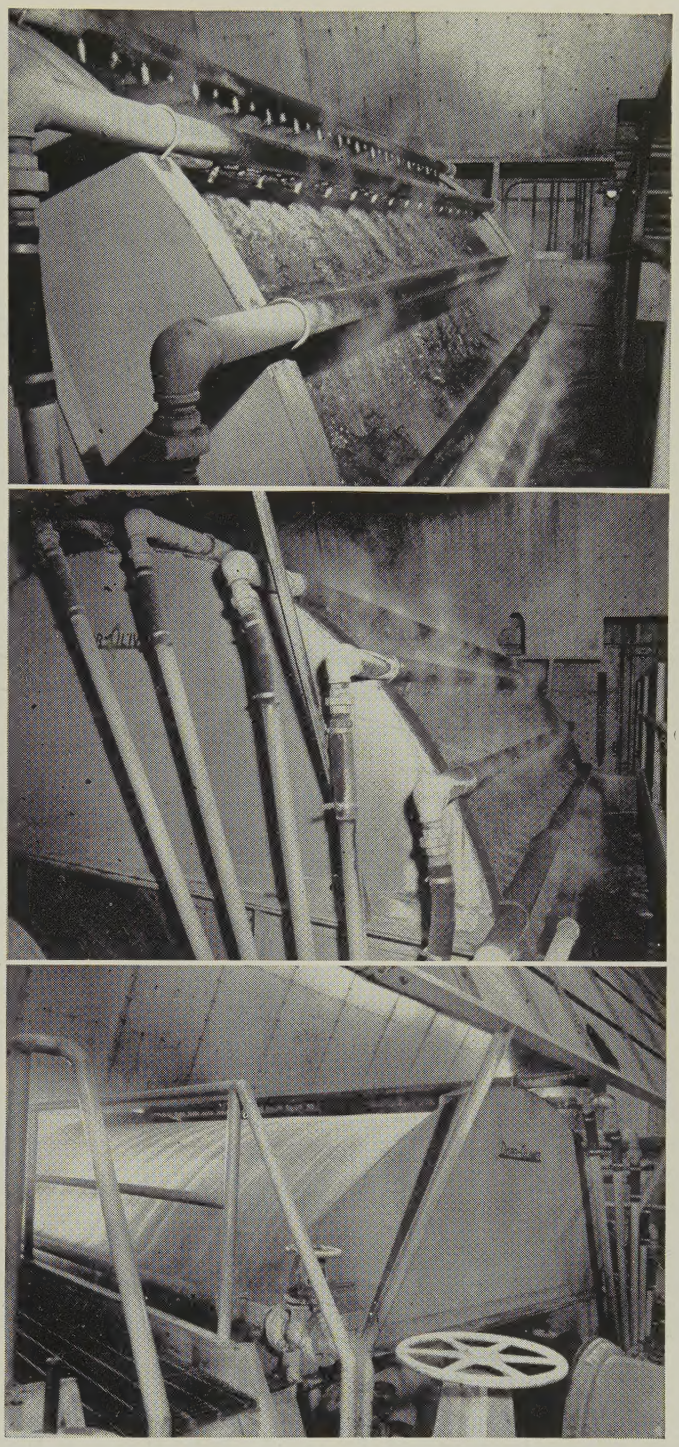
Three Oliver Type 55F cone valve Brownstock Washers, each 11'6" diameter x 16' face, with 478 square feet of filtering area, handle a peak load of 390 tons per day. Wood is Douglas fir.

As with other Oliver Brownstock Washer installations, distinctive features include: high efficiency, uniform sheet formation, high hydraulic capacity, and unusual ability to handle peak loads.

The success of the Oliver Brownstock Washing System is based on knowledge gained from more than 35



Overall view shows the three Oliver Type 55F cone valve Brownstock Washers installed in the Weyerhaeuser mill.



Three stages of the washing operation are shown in these photos. Note the clean, uniform sheet formation in the final stage.

years of designing, engineering and servicing hundreds of Washers in the pulp and paper field, as well as thousands of filters in the process field in general.

For more complete information on the Oliver Brownstock Washing System write for a copy of Bulletin No. 3303, Dorr-Oliver Incorporated, Stamford, Connecticut. Better still, let us send a Dorr-Oliver engineer to discuss your specific filtration or washing problem with you, placing at your disposal the wealth of information accumulated through our 35 years of Brownstock Washing experience.

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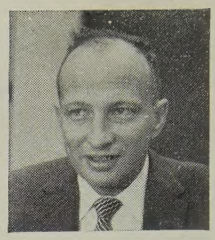
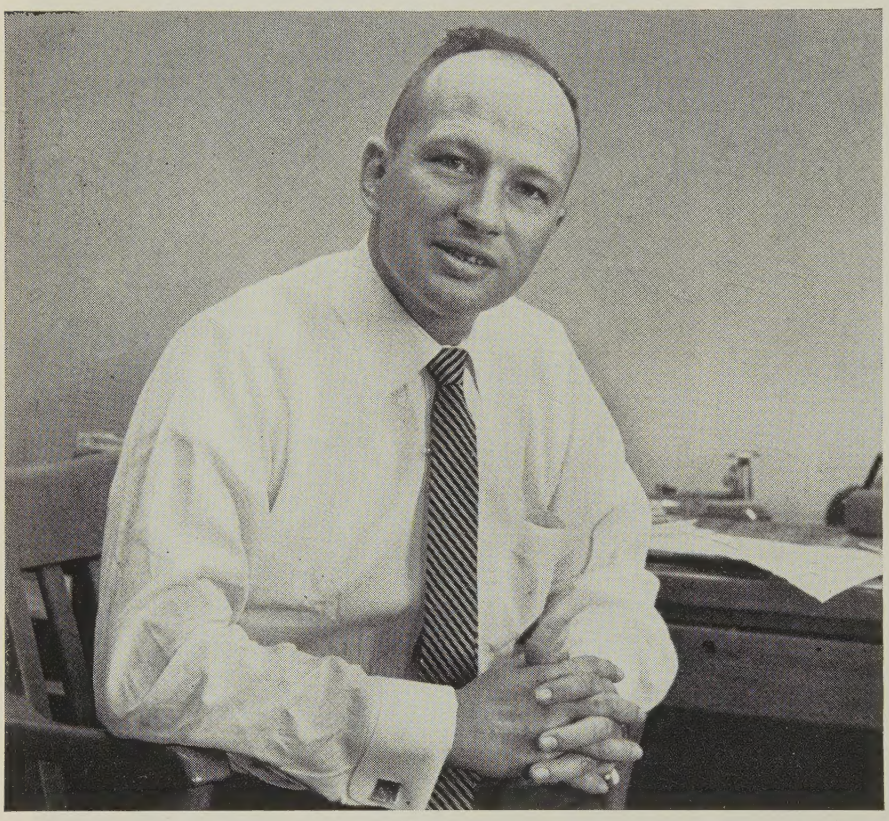
One in a series of interviews with the men who are "Virginia"



"Combination bleaching of mechanical pulp – following peroxide with a hydrosulfite – can give you brightness gains of 15 to 20 points"

Robert Barton, a technical representative for Virginia Smelting Company, discusses the advantages of 2-stage bleaching from the standpoint of costs and results.



Robert Barton, a "Virginia" technical representative

Q Why does 2-stage bleaching give more brightness gains?

A Because the action of peroxide and hydrosulfite on pulp is not the same. Each gains its effect in a different way, and while there is some overlap in their action, there is a very worth-while cumulative effect. In other words, where you can reasonably expect a brightness gain up to 12 points using either bleach alone, the two bleaches used consecutively jump the results to anywhere from 15 to 20 points.

Q What are the advantages of 2-stage bleaching?

A Lower costs and better results—especially if the mill is now using some agent other than hydrosulfite for its single-stage bleaching. The big financial advantage in switching to a combination bleach goes to the pulp mill now using a single stage of peroxide.

Q How does the 2-stage bleach cut costs?

A The principle is to use as little of the more expensive peroxide as possible. The first stage is a bleach with peroxide. Follow this with a hydrosulfite bleach and you have cut the heart out of bleaching costs, at the same time stepping up the quality of the final product. Higher brightness and lower costs are the main reasons why 2-stage bleaching is becoming increasingly popular.

Q Can this process be applied to any kind of pulp with the same results?

A No, the response varies slightly with the wood from which the pulp is made. Good results have been obtained with spruce, poplar and pine groundwood pulps and with a large number of semimechanical pulps made from many species of caustic or sulfite pretreated hardwoods. Mixtures of chemical and mechanical pulps also respond favorably.

Q How can pulp manufacturers find out whether or not the 2-stage bleach will be advantageous to them?

A Simply by calling on the services of "Virginia." We can bring our lab equipment right into a mill, make tests, and demonstrate the possibilities of 2-stage bleaching under practical operating conditions. We will lend the mill any necessary equipment, find a spot in the system where the hydrosulfite stage can be inserted, and help run a mill trial. If the 2-stage process proves desirable, we will stay on the job and help iron out any technical problems that might arise. Under circumstances like these a pulpmaker can easily see where costs are being cut—and examine the improved final product with his own eyes. This is the kind of technical service on which "Virginia" has built its reputation.

• • •

For more information on 2-stage bleaching with "Virginia" zinc or sodium hydrosulfite, write us giving any technical data that may help us evaluate your problem. We will forward technical literature and run laboratory tests provided you furnish us fresh pulp samples. Or, if you say so, we will have a "Virginia" man call and talk over your requirements with you.

Industrial Division

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Dept. 318 West Norfolk, Va.

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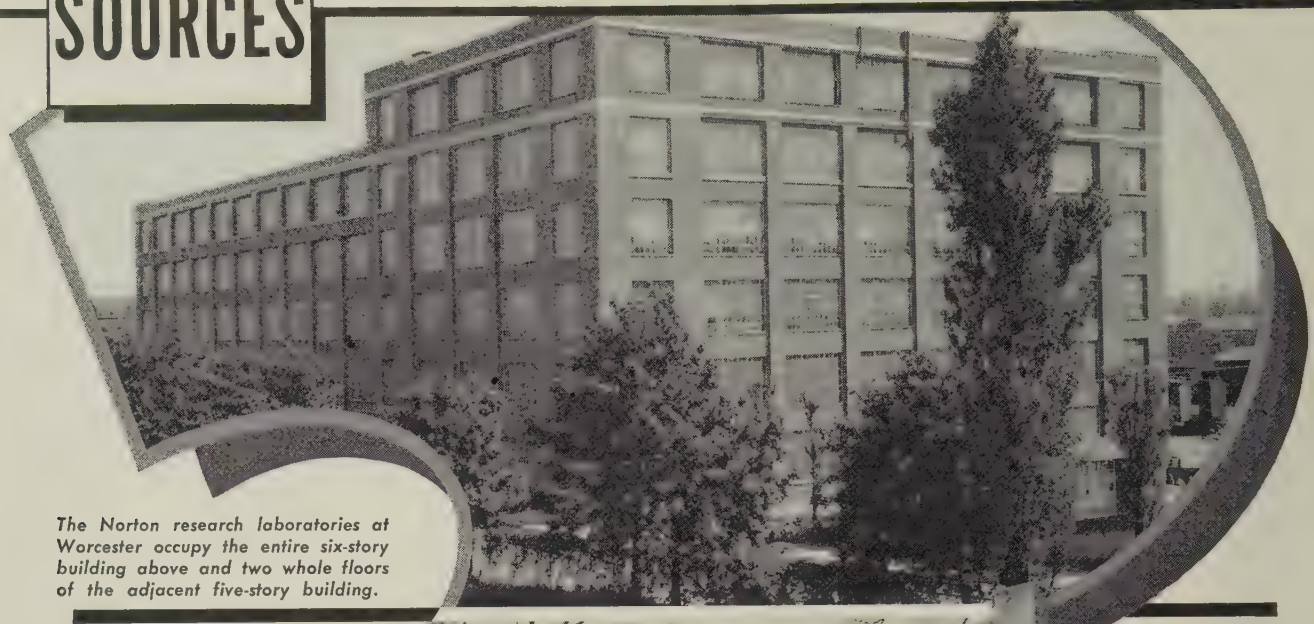

The Norton research laboratories at Worcester occupy the entire six-story building above and two whole floors of the adjacent five-story building.

The Norton research laboratories building at the Chippawa, Ontario electric furnace plant.

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In Norton Company laboratories, both in Worcester and in Chippawa, Ontario, more than 185 research men and technicians are constantly at work applying a wide variety of highly specialized knowledge to the development of better abrasives, pulpstones, grinding wheels, and other Norton products.

From the Norton manufacturing plants at Worcester and at Hamilton, Ontario, hundreds of pulpstones go out each year to meet the world's requirements for mechanical pulp.

Thus users of Norton pulpstones have the benefit of research developments from two major sources — are served by two completely independent sources of manufacture — both with *one* high standard of quality and service.

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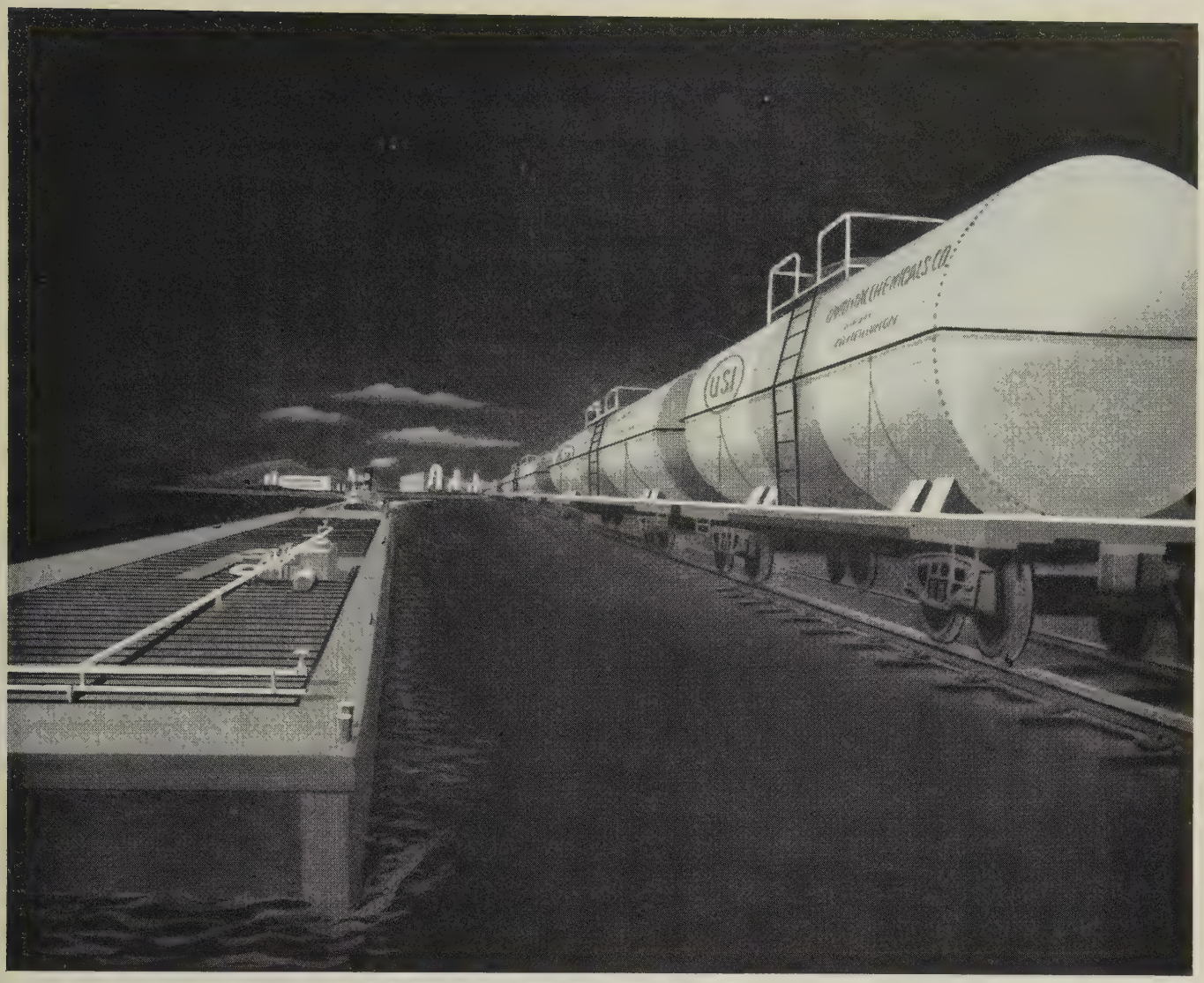

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For additional information, call your local Bailey District Office, or write us direct.

P47-1

Pulp and paper division

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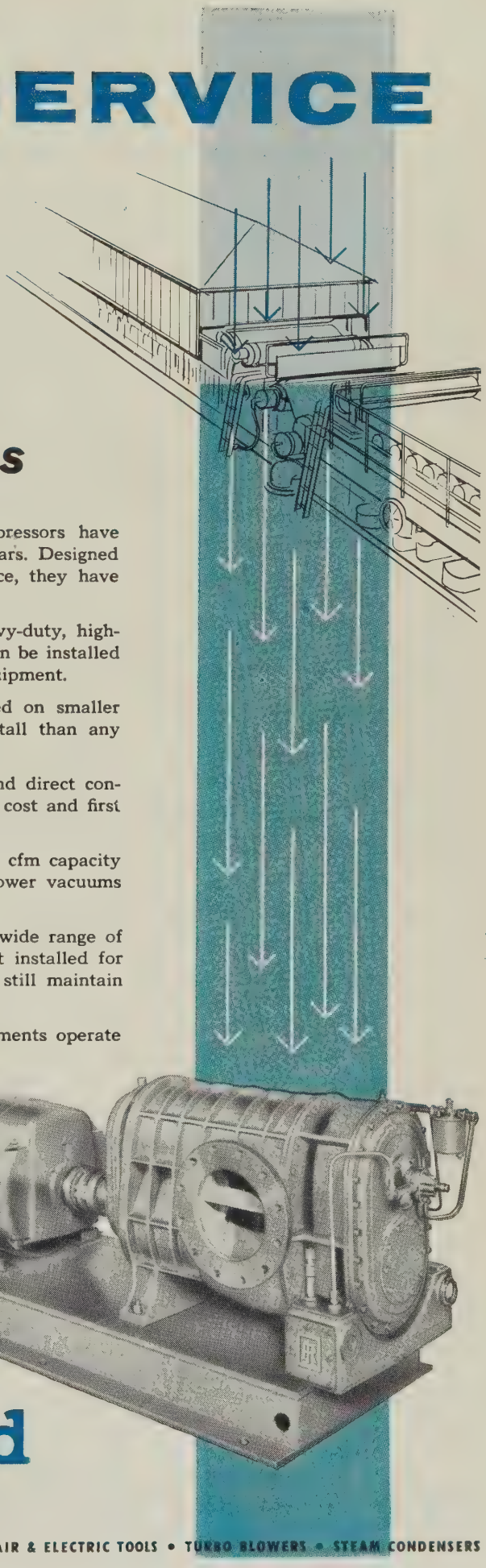

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Organisation for European Economic Co-operation

1ST HALF YEAR—1958

The Organisation for European Economic Co-operation comprises the following Member countries: Austria, Belgium, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Sweden, Switzerland, Turkey and the United Kingdom. The Organisation came into being with the signing of the Convention for European Economic Co-operation on April 16, 1948, when Member Governments pledged themselves "to combine their economic strength, to join together to make the fullest collective use of their individual capacities and potentialities, to increase their production, develop and modernise their industrial and agricultural equipment, expand their commerce, reduce progressively barriers to trade among themselves, promote full employment and restore or maintain the stability of their economies and general confidence in their national currencies." Representatives of each of the Member countries meet daily at the O.E.E.C. headquarters, Château de la Muette, Paris, to discuss their economic problems and work out common solutions. The United States and Canada participate in all the work of the Organisation as Associate Members. Spain participates, as a full Member and on an equal footing with the Member countries, in the work of the agricultural bodies of the Organisation and is associated in its other activities. Yugoslavia is represented by an observer and like Spain also participates in the work of the European Productivity Agency.

THE following figures in units of 1000 metric tons, summarize the trend of the pulp, paper and board market during the first six months of 1956, 1957, and 1958, in the O.E.E.C. countries as a whole and Finland.

	1st six months, 1956	*1st six months, 1957*	*1st six months, 1958*
Production of woodpulp for papermaking	5,173	5,567(+7.6%)	5,500(−1.2%)
Production of dissolving pulp	519	548(+5.6%)	516(−5.8%)
Production of paper and board	7,368	8,035(+9%)	7,977(0.7%)
Consumption of paper and board	6,816	7,444(+9%)	7,596(+2%)

The expansion of the pulp and paper sector, which was still very rapid in the first six months of 1957, then slowed down to such an extent that the achievements of the second six months of 1957 for the countries as a whole did not exceed those of the first six months and were sometimes even lower.

As pointed out by the Committee in May, 1958, the trends in the first six months of 1958 were the same as those recorded in the last few months of 1957: the statistics now show that the production of woodpulp for papermaking and the production of paper and board for the countries as a whole were in fact almost identical to the figures for the first six months of the previous year. Consumption of paper and board still increased, however, but less rapidly than in the previous periods.

An examination of detailed statistics by countries shows that the slowing-down of expansion is more pronounced in the producing-exporting countries (northern countries and Austria) than in the net importing countries.

Pulp production fell in Sweden, Norway, and Austria, but remained steady or even rose slightly in the other countries (Finland also showed a certain increase). Production of paper and board fell in northern countries and Austria but remained generally steady or was slightly higher in the other countries.

It is thus clear that countries which have to import a more or less substantial proportion of the pulp and paper which they consume, have cut their imports more than the rate of home production, when confronted with a slackening in the rate of expansion of paper and board consumption.

This fall in demand on the export markets first led to a reduction of production in these countries and then to a certain reduction in the FOB prices of pulp for papermaking which reached 4 to 8% for chemical pulp and 10% for mechanical pulp.

WOODPULP FOR PAPERMAKING

Production and Consumption

Production of Woodpulp for Papermaking. In the aggregate and for the countries combined (O.E.E.C. + Finland), the production of woodpulp for paper and board making varied little in the first six months of 1958 as compared with the same period of 1957.

	1st six months, 1956	*1st six months, 1957*	*1st six months, 1958*
Mechanical pulp	2,000	2,110(+ 5.5%)	2,046(−3%)
Kraft pulp[a]	1,001	1,145(+14.4%)	1,109(−3.2%)
Other woodpulp	2,172	2,312(+ 6.4%)	2,335(+1%)
Total	5,173	5,567(+ 7.6%)	5,490(−1.4%)

[a] Sulphate pulp (unbleached only).

The trend is slightly different in the producing countries—Austria, Norway, Sweden, Finland (which account for 73% of total output): Norway and Sweden reduced their production by 9% and 2% (−55,000 tons and −47,000, respectively), Austria by 5% (−13,000 tons), whilst Finland increased it slightly (+26,000 tons, or +2%). In the other countries, production remained at the level reached during the first six months of 1957; in France there was even an increase in production (+25,000 tons, i.e., + 6%).

Total production of mechanical pulp varied little as compared with the first six months of the previous year (64,000 tons, i.e., −3% approximately). This reduction is mainly attributable to Norway (−43,000 tons, −12%), Sweden (−30,000 tons, −7%) and Austria (−9,000 tons, −11%) for

This report, published here in part, reviewing the statistics for the first half of 1958, was approved by the Pulp and Paper Committee on Nov. 25, 1958 and published in January, 1959. There are appended statistical tables containing figures given by the Governments in the full report which is available from O.E.E.C. Publications Office, 1346 Connecticut Ave., N.W., Washington 6, D. C. at $1.00 per copy.

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in the other countries production remained stationary (Germany, Italy) or even increased (Finland, France).

In the kraft pulp sector, where expansion had been greatest during the first six months of 1957 (+14%), there was a slight slackening in the production of the countries as a whole (−3.2% or −36,000 tons). A considerable reduction in Swedish production (−40,000 tons or −7%) was partly offset, however, by increases in Finland and France.

The sector "other woodpulp" at present mainly consists of sulphite pulp, unbleached and bleached, and of bleached sulphate pulp (a detailed breakdown is given in the statistical annexes). In this sector as a whole, production remained more or less stationary as compared with the first six months of 1957; it is the only sector where production did not decrease. Production in France increased by 5% (+8,000 tons), and in Sweden by 2% (+23,000 tons). In Finland and Austria there was little change in production.

Apparent Consumption† of Woodpulp for Papermaking. Like production, total consumption of woodpulp for paper making in the member countries and Finland, remained almost stationary as compared with the first six months of 1957. The figures for consumption of kraft pulp and "other woodpulp" are the same, but total consumption of mechanical pulp fell by 50,000 tons (2.4%).

	1st six months, 1956	*1st six months, 1957*	*1st six months, 1958*
Mechanical pulp	2,003	2,103(+ 5%)	2,053(−2.4%)
Kraft pulp	940	1,077(+14.6%)	1,078(=)
Other woodpulp	2,226	2,409(+8.2%)	2,408(=)
Total	5,169	5,589(+ 8%)	5,539(−1%)

The most substantial reduction in mechanical pulp consumption took place in the largest consumer country, the United Kingdom, amounting to 44,000 tons (−12%) as compared with 1957, and 15,000 tons as compared with the first six months of 1956. Austrian consumption fell by 6% (−5000 tons) as compared with the previous year. In the other countries, if mechanical pulp consumption sometimes differs from that of the 1st six months of 1957, it is in such cases more or less the same as for the 1st six months of 1956.

In the kraft pulp sector, the only salient feature seems to be an increase in consumption, in France and Finland, a trend which had been apparent for three years (for France 18%, or 24,800 tons more than in 1957 and 29%, or 36,500 tons more than in 1956; for Finland 12%, or 24,000 tons more than in 1957 and 62% or 85,000 tons more than in 1956).

Total consumption of "other woodpulp" varied little as compared with the first six months of 1957, consumption in the United Kingdom and Germany, the two largest consumers, remaining stationary. Consumption rose, however, in France (+34,000 tons or 11.7% approximately). Consumption in Finland, Austria and Norway fell by 15, 10 and 5%, respectively.

International Trade in Woodpulp for Papermaking

Trade Among O.E.E.C. Countries. An examination of the trade in wood pulp for papermaking for this area reveals a fall in total imports of approximately 7% (−86,000 tons)as compared with the first six months of 1957 (Germany being the only major country which increased its imports in this area).

If the trends for the main categories of pulp are compared, it is found that it is the fall in imports of mechanical pulp in most countries (20%—86,000 tons) which accounts for this decline in activity.

Imports of kraft pulp fell only very slightly (171,000 tons as agains 179,000 in 1957), and imports of "other woodpulp" even increased a little (639,000 tons as against 630,000 in 1957).

Imports of Woodpulp for Papermaking from Finland and Third Countries. The total volume of trade of O.E.E.C. countries with other countries remained more or less unchanged.

Imports from Finland increased by approximately 6% (+24,000 tons): i.e., +4000 tons for kraft pulp and +38,000 tons for "other woodpulp," with a fall in mechanical pulp (−18,000 tons).

Imports from the Western Hemisphere declined considerably (12.4%), even falling below the already low level of the first six months of 1956; this fall is due to the decline in imports of "other woodpulp" (−32,000 tons as compared with the first six months of 1957), as imports of kraft pulp varied little (18,000 tons as against 21,000) and imports of mechanical pulp, almost entirely for the United Kingdom, increased by 10,000 tons (amounting to 17,000 tons).

Imports of Woodpulp for Papermaking from Finland and Third Countries

From	*1st six months, 1956*	*1st six months, 1957*	*1958*
Western hemisphere	190	202	177(−12.4%)
Finland	411	399	422(+ 5.8%)
Other countries		75	80
Total	601	676 (+12%)	679

Exports of Woodpulp for Papermaking from the O.E.E.C. Countries and Finland to Third Countries. The total of these exports fell by approximately 5% as compared with the first six months of 1957 and reverted to the level of the first six months of 1956 as a result of the fall in exports from Sweden and Finland to the Western Hemisphere (6000 tons and 20,000 tons respectively), while the exports from Norway increased by 6000 tons. Exports to the other third countries remained at the same level.

Exports of Woodpulp for Papermaking from the O.E.E.C. Countries and Finland to Third Countries

	1st six months, 1956		*1st six months, 1957*		*1st six months, 1958*	
		Of which Finland		*Of which Finland*		*Of which Finland*
To the Western hemisphere	235	111	234	96	214	76
To "others"	113	41	124	64	127	68
Total	348	152	358 +3%	160	341 −5%	144 −10%

OTHER PULPS

Waste Paper

The rate of expansion of waste paper salvaged and use was lower than in the previous six-monthly periods. For the countries as a whole, the increase was about 3.5% for salvage and approximately 4% for consumption; this is mainly due to the trend in France, Italy and Germany, as the figures for the other countries are more or less the same as in 1957.

The volume of trade, which in this sector is practically confined to trade between Member countries, was slightly less than in the same period of the previous year.

Pulp of Other Fibrous Materials

For the first time, separate statistics are available for pulp of fibrous materials other than wood:

Chemical pulp of annual vegetable products
Semichemical and macerated straw pulp
Chemical pulp, of rags

† Apparent consumption = production + imports − exports.

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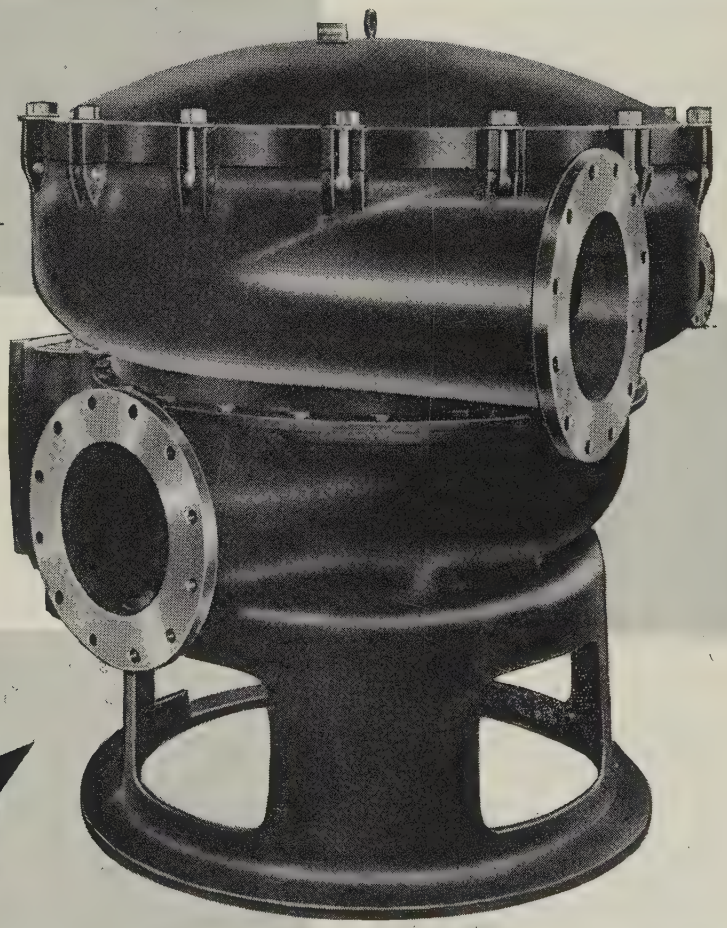

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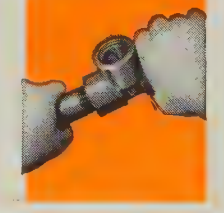

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Owing to the new definitions used, it is not, however, possible to compare the figures now obtained with the previous statistics: formerly it was theoretically a question of fibrous materials counted for their pulp equivalent, whereas it is now clear that these headings concern pulp.

An examination of the data shows that chemical pulp of annual vegetable products is practically the only item concerned in internal trade and that this trade is not very considerable.

These different types of pulp are at present nearly all produced and consumed by the countries of the Community and by the United Kingdom.

Production and Consumption

Both production and consumption of dissolving pulp are down on the first six months of 1957. While production fell by nearly 6% (−32,000 tons) as compared with 1957 and is more or less back at the 1956 level, the slackening of consumption in 1958 was far more appreciable (−43,000 tons); nevertheless, the level of consumption is still higher than in 1956. The largest

	1st six months, 1956	*1st six months, 1957*	*1st six months, 1958*
Consumption	519	548(+5.6%)	516(−5.8%)
Production	491	542(+10.4%)	499(−8%)

producer, Germany, reduced production by nearly 19,000 tons, while Sweden's reduction is even greater (−22,000 tons, −11%). In the other countries, the level of production scarcely varied (Finland, Italy) but there was a tendency to increase in Austria, France, and Norway.

Consumption declined in Germany (−35,600 tons, −23%), in Italy, and Switzerland; in the other countries, it remained stable or increased.

International Trade in Dissolving Pulp

Trade Among O.E.E.C. Countries. Imports of dissolving pulp fell by nearly 16% (−36,000 tons) as compared with the first six months of 1957, as exports from the producing countries (Austria, Norway, Sweden, Finland) showed a tendency to fall. Swedish exports in particular decreased by approximately 20%.

Imports from Finland and Third Countries. Member countries' imports from this area declined by 12,000 tons (−10%) following the reduction in imports from the Western Hemisphere

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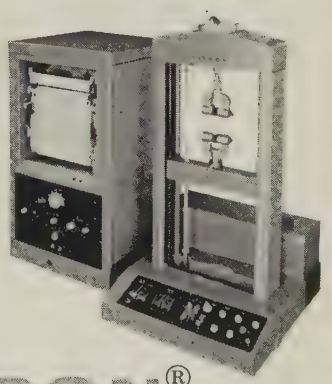

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(−13%) and Finland (−28.4%). Imports from "other countries," on the other hand, increased. This change in the breakdown is mainly due to the United Kingdom, which reduced imports from the Western Hemisphere and Finland in favour of other third countries (Union of South Africa).

	1st six months, 1956	*1st six months, 1957*	*1st six months, 1958*
Western Hemisphere	58.3	82.3	71.8
Finland	25.3	24.7	17.7
Other countries		18.8	24.2
Total	83.6	125.8 (+50%)	113.7 (−10%)

Exports from O.E.E.C. Countries and Finland to Third Countries. These exports increased by about 8000 tons, mainly as a result of the rise in exports to the Western Hemisphere (11,600 tons as against 5300 tons in 1957).

	1st six months, 1958	*Of which Finland*	*1st six months, 1957*	*Of which Finland*	*1st six months, 1958*	*Of which Finland*
To the Western Hemisphere	8.3	4	10.3	5	14	2.4
To "others"	80.3	37	94.8	50	101.4	54.7
Total	88.6	41	105.1 +19%	55	115.4 +9.8%	57.1

Exports from Finland to the Western Hemisphere, which were always low, fell still further; on the other hand, its exports to "other countries" are still increasing and in 1958 exceeded the 1956 level by 47.8% (i.e., 17,700 tons).

PAPER AND BOARD

Production and Consumption‡

	1st six months, 1956	*1st six months, 1957*	*1st six months, 1958*
Total paper and board of which:	7,368	8,035(+9%)	7,977(−0.7%)
Newsprint	1,552	1,673(+7.8%)	1,541(−8%)
Kraft paper and board	871	953(+9.4%)	942(−1.2%)
Other paper and board	4,945	5,409(+9.4%)	5,494(+1.6%)

Production. In the first six months of 1958, production of paper and board in the countries as a whole hardly varied as compared with the first six months of the previous year. There was, however, a general decline in northern countries' production (about 5% for Norway and Sweden, and about 3.4% for Finland) and Austria (−5% also). The largest producer, the United Kingdom, has more or less the same production figures as in 1957. Germany and France, which come second and third among paper and board producers, both increased their production by 40,000 tons (+2.9 and 3.6%, respectively).

The newsprint sector is the only one in which there was a considerable reduction in the production of Member countries and Finland (−132,000 tons, i.e., −8%). All countries (except Belgium and Italy) reduced their output sometimes to quite a considerable extent (Finland by almost 13%, −43,000 tons), the United Kingdom and France by 8% (−29,500 tons and −18,000 tons), Germany by 9% (−13,000 tons).

Production of kraft paper and board was more or less the same as in 1957. There, too, the downward trend is general, except however, in France, Finland, and Norway where the level increased by 21% (+21,000 tons), 6% (+11,000 tons) and 5% (+2,000 tons), respectively.

The only sector in which a very slight expansion may be noted is "other paper and board," this slight increase being due in particular to the United Kingdom, France, and Germany which raised production by 3 to 5%. Sweden, Italy, Finland, Austria, and Switzerland remained at the 1957 level while production in the Netherlands and Norway fell by about 8% and 5% (−31,000 tons and −8000 tons).

	1st six months, 1956	*1st six months, 1957*	*1st six months, 1958*
Total paper and board of which:	6,816	7,444(+ 9.2%)	7,596(+2%)
Newsprint	1,386	1,465(+5.7%)	1,465 =
Kraft paper and board	818	932(13.9%)	935 =
Other paper and board	4,612	5,047(9.4%)	5,196(+3%)

Consumption. For the countries as a whole (O.E.E.C. + Finland) there was a slight increase in apparent consumption (+152,000 tons, i.e., approximately 2%) of all paper and board.

However, in view of decline in stocks, it is thought that actual consumption was somewhat higher.

This increase is as follows for the three major consumers:

United Kingdom: +76,000 tons (3%)
Germany: +76,000 tons (5%)
France: +34,000 tons (3%)

There was a reduction in consumption in the Netherlands (−49,000 tons, 12%) and the B.L.E.U. (−29,000 tons, 11%).

An analysis of the trend by sectors reveals the stability of newsprint consumption: however, a substantial increase in the United Kingdom (+68,000 tons, i.e., 15%) and a quantitatively smaller increase in Italy, Austria, and Denmark offset a reduction in most other countries.

Consumption of kraft paper and board remained practically unchanged in the two main consumer countries: United Kingdom, Germany. The only salient feature in this sector seems to be the increase in French consumption (+25,000 tons, i.e., 23%) and the reduction in Sweden, B.L.E.U. Netherlands, and Italy.

In the sector "other paper and board" there was an increase in consumption in Germany (+93,000 tons, +7.5%), Sweden (+22,000 tons, +10%) and Norway (+15,000 tons, (+23%), whereas consumption in the United Kingdom, France, Italy, and Finland scarcely varied as compared with the first six months of 1957. The only outstanding reductions in consumption were recorded in the Netherlands (−33,000 tons, i.e., −11%), Belgium and Austria.

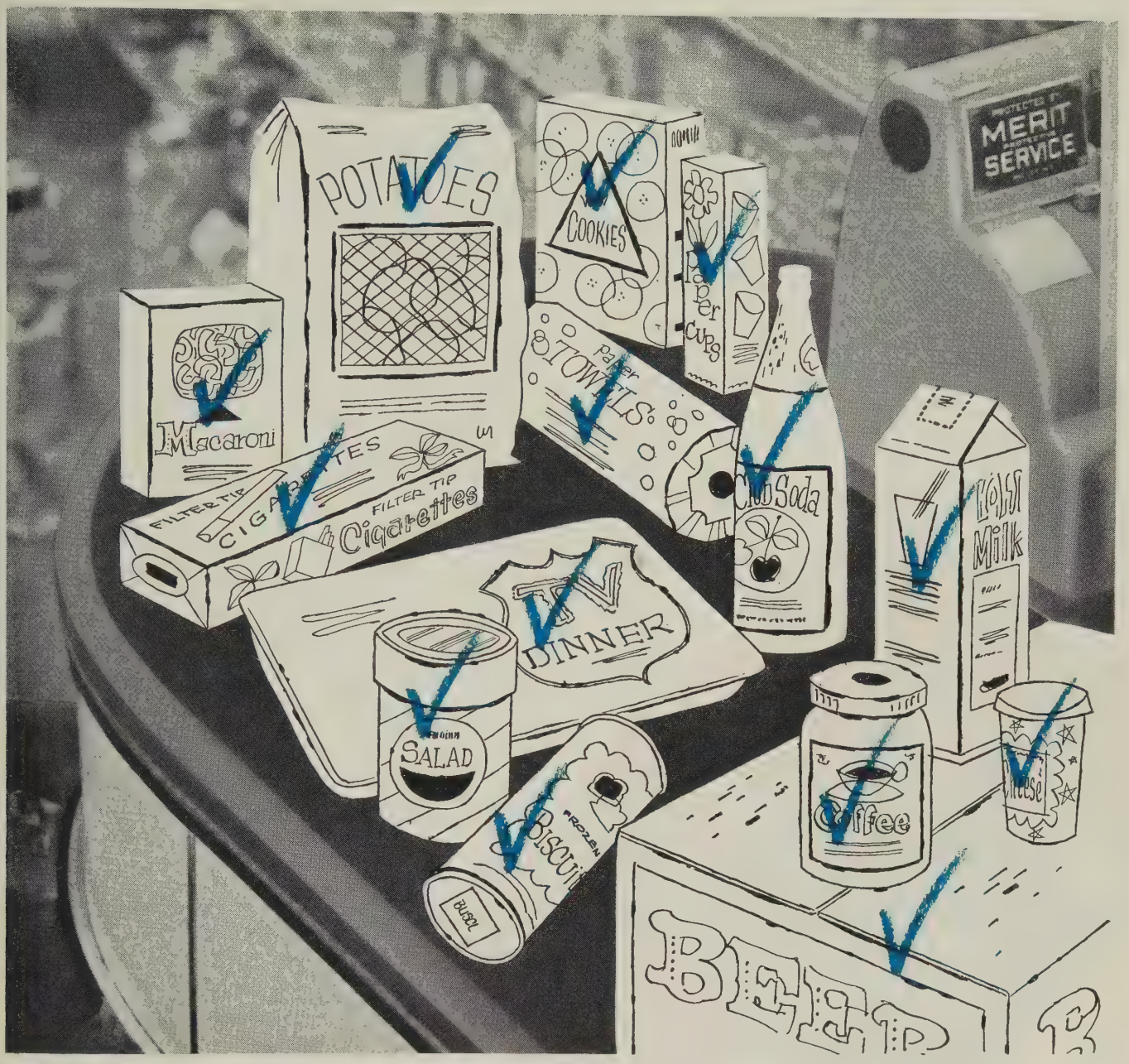
International Trade in Paper and Board

Trade Among O.E.E.C. Member Countries. Imports from Member countries fell slightly (−57,000 tons approximately, i.e., −7%) as compared with the first six months of 1957. In the principal importing countries, varying trends may be noted: whereas the United Kingdom and France reduced their imports by 18 and 36% (−44,000 tons and −34,000 tons), German imports rose by approximately 33,000 tons, i.e., +19%.

Trade in newsprint and kraft paper and board among Member countries fell more heavily (nearly −8%) than trade in "other paper and board" (−6.6%).

Imports from Finland and Third Countries. For the first time in three years, imports of paper and board from the Western Hemisphere did not increase: they are not quite up

‡ That is "apparent consumption": production + imports − exports.



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From	*1st six months, 1956*	*1st six months, 1957*	*1st six months, 1958*
Total paper and board:			
Western Hemisphere	274	303 (+10.6%)	297(−2%)
Finland	235	289	336 299(+3.5%)
Other countries		25 314(+33%)	37(+48%)
Total	509	617	633

to the 1957 level. The United Kingdom, which alone accounts for 85% of the paper and board imported from this area in 1958, did increase imports slightly (+2.7%, i.e., nearly 7000 tons) but this increase could not make up for the decline in imports into the Netherlands (−5400 tons, −72%) and Germany (−5000 tons, −27%); the figures for other countries scarcely varied. The United Kingdom's imports, moreover, followed differing trends, according to the sectors: purchases of newsprint, which form the major proportion of these imports, fell from 1957 to 1958 by 4% (nearly 7000 tons) whilst those of kraft paper and board increased substantially (+24%, i.e., +17,000 tons) during the first six months of this year.

Exports from O.E.E.C. Countries and Finland to Third Countries

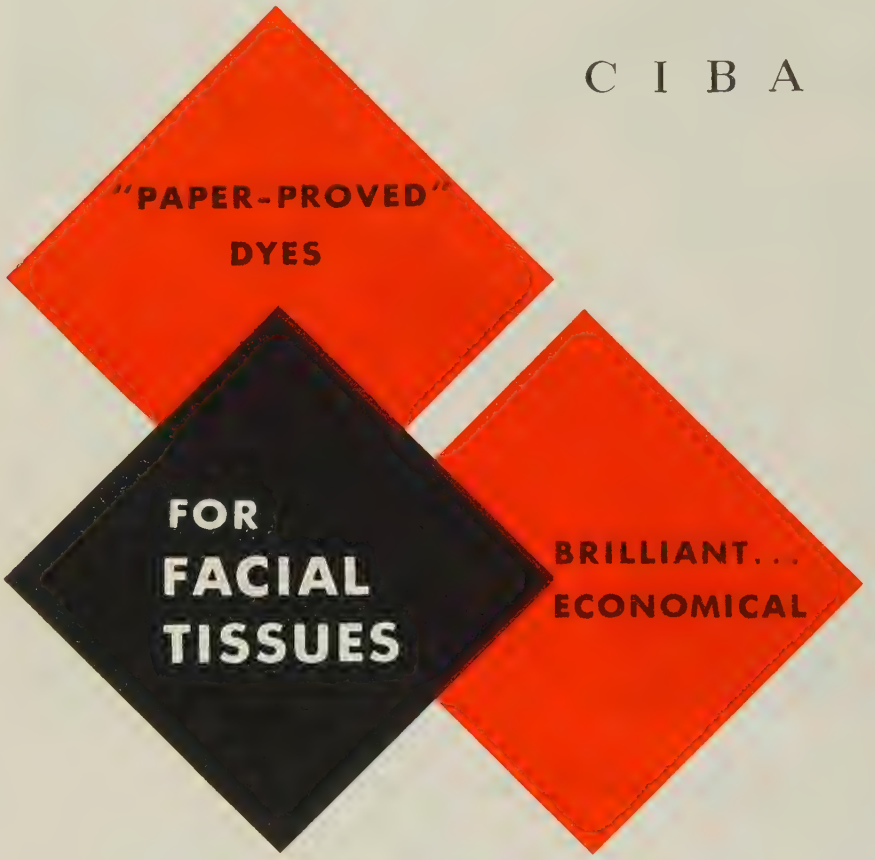
	1st six months, 1956	*Of which Finland*	*1st six months, 1957*	*Of which Finland*	*1st six months, 1958*	*Of which Finland*
Total paper and board:						
To Western Hemisphere	326	148	289	157	245 (−15.2%)	128 (−18%)
To other countries	386	92	407	121	385 (−5.4%)	129 (+6%)
Total	712	240	696	278	630 (−9.5%)	257 (−7.6%)

Total imports from Finland and third countries, which had increased by 79,000 tons (+33%) from 1956 to 1957, increased at a slower rate from 1957 to 1958 (+7% only, i.e., 22,000 tons). Most of these imports (89%) still come from Finland. They are slightly higher than in the previous year as a result in particular of the increase in United Kingdom imports of newsprint (+36%, i.e., +17,000 tons) from that country. The increasing importance of Member countries' imports from "other third countries" should, however, be noted: they are still small in volume, (37,000 tons) but nevertheless increased by nearly 50% as compared with the corresponding period of 1957.

Exports from O.E.E.C. Countries and Finland to Third Countries. Total exports from the O.E.E.C. countries and Finland to third countries declined by 10% (−66,000 tons).

Exports to the Western Hemisphere which has fallen by 37,000 tons (11%) in 1957, as compared with the first six months of 1956, fell again by 44,000 tons (15%) between 1957 and 1958. Except for Sweden, where the 1957 level was more or less maintained, the reduction in exports affected all countries: as examples we need only mention Finland (−29,000 tons, −18%), Austria (−6000 tons, −38%) and Norway (−3300 tons, −12%). This reduction mainly affects exports of newsprint from these three countries.

Exports from O.E.E.C. countries and Finland to third countries other than those of the Western Hemisphere were also lower than in 1957 (−22,000 tons). While Finland managed to increase exports to these countries, this was not the case for the United Kingdom, Sweden, and Norway—where the level of exports fell by 12 to 13%. This reduction in United Kingdom exports of newsprint (−20,000 tons approximately) could not be offset by the increase in exports of "other paper and board" (+9000 tons approximately). In Sweden, the reduction mainly affects kraft paper and board, in Norway "other paper and board."



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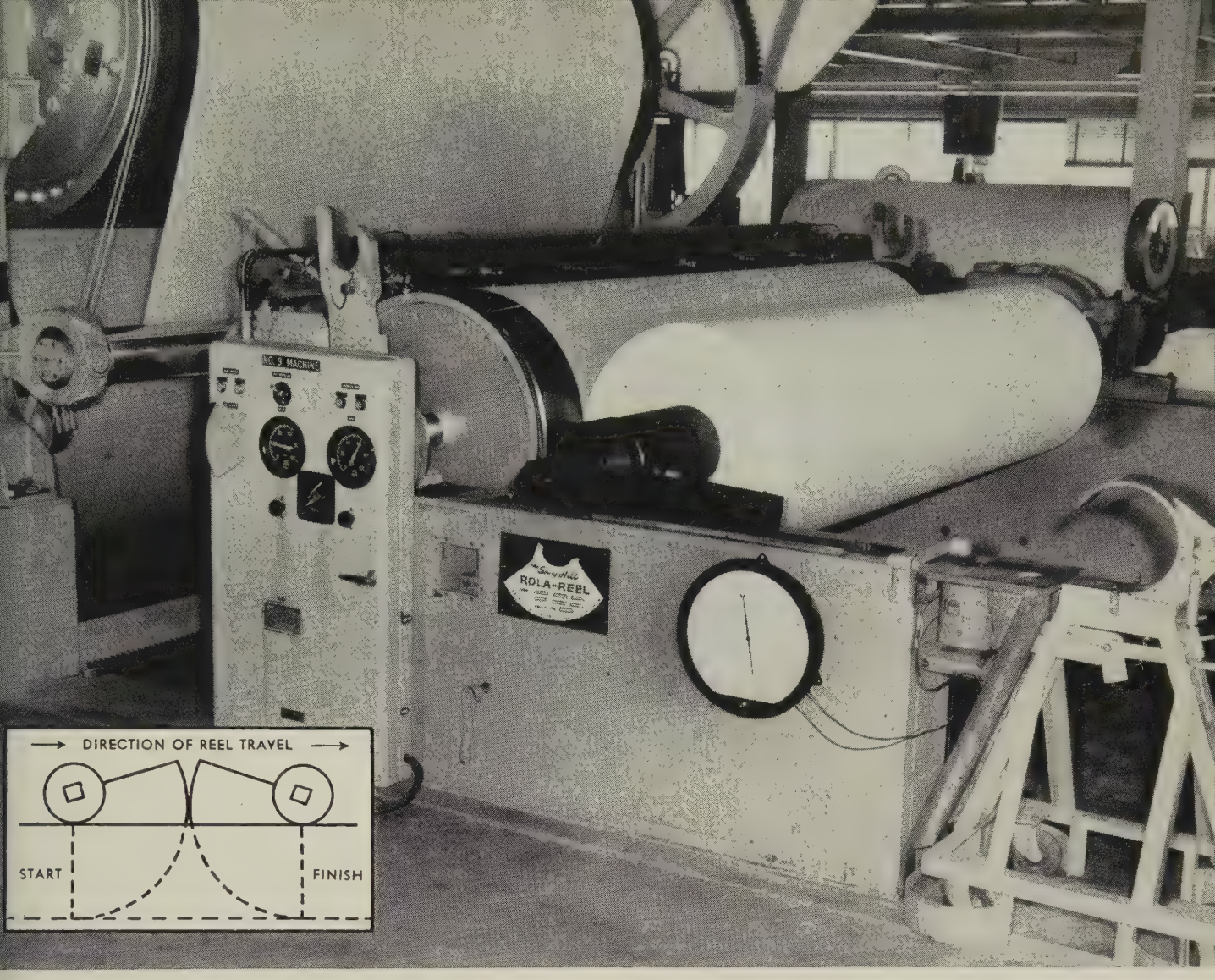
CIBA offers a wide selection of dyes which are "paper-proved" for facial tissues . . . proved under all operating conditions and for fastness characteristics required for this use.

The brilliance and fastness to light of these direct dyes are outstanding . . . and their fastness to crocking and bleeding is excellent too.

Combining high tinctorial strengths and moderate prices per pound, these products bring important economy advantages to the dyeing of facial-grade tissues produced from bleached pulps.

The direct dyes listed at left are a selection of CIBA products recommended specifically for this application.

CIBA Company Inc., Paper Chemicals Department
627 Greenwich Street, New York 14, N. Y.



A BRAND NEW REEL CONCEPT . . .

THE SANDY HILL Rola-Reel

ensationally new and far ahead of the parade, the Sandy ill **Rola-Reel** already is building a record of proven erformance.

ustomers acclaim the substantial reduction in paper loss the reel, and also the improved firmness and evenness winding.

he unique quadrant reel carriage reduces friction by subituting rolling for sliding motion, resulting in a new accucy in control of nip pressures.

Finished reel automatically discharges to back of the reel stand, the carriage immediately returning to receive new spool. The finished roll of paper may be rolled directly onto skid or unwinding stand, thus requiring no crane.

Dial indicator showing reel diameter, a weighing device giving roll weight right at the reel, and a panel for fingertip control of reeling are optional equipment. Sandy Hill also builds lightweight reels, **Pope-type** constant speed reels, and the **Dualode** for heavy duty pulp service.

WRITE FOR DESCRIPTIVE BOOKLET AND COMPLETE TECHNICAL DETAILS

THE
SANDY HILL
IRON AND BRASS WORKS
HUDSON FALLS, N. Y.

Quality Control Inspection from the Customers Viewpoint

ROBERT T. HOLT

BEFORE I delve into the mechanics of Scott Paper Co.'s quality control inspection procedure for corrugated cases, I would like to give you just a few of the facts which justify our establishing such a system.

Due to the very nature of the products which are produced, and the methods by which these products must be transported and then merchandised, we find ourselves purchasing and using corrugated boxes of many different sizes and types of construction—boxes with different types of joints, boxes with different strength requirements, and boxes with a myriad of artwork and printing designs.

Daily, the Chester plant produces approximately 30,000 cases of paper products. These 30,000 cases represent about 15 different brands or grades of tissue, and over the course of a week's time it is quite possible that 30 different brands will be produced and shipped to consumers. These products are packaged in folding cartons and sleeves, paper and cellophane, and paper bags, and should reach the consumer in the same condition that they left our plant. Each brand, as you can appreciate, has its own corrugated shipping container, and each container must meet the specifications which have been established for it.

Our plant operates three shifts per day and 7 days a week and in order to maintain the efficiencies required, it is imperative that corrugated shipping containers be put into production with confidence that they will perform the job expected of them.

SPECIFICATIONS FOR CORRUGATED SHIPPING CONTAINERS

All packaging material specifications are set up by the Staff Packaging Division of Scott Paper Co. This division distributes these specifications to the individual plant packaging departments and the Staff Purchasing Department. It is then the responsibility of the Staff Purchasing Department to provide all suppliers with specifications for the materials which they are to provide to each of the plants of the company.

At the present time, 18 different corrugated container companies are supplying Scott with shipping containers.

Corrugated case specifications are established so as to provide our suppliers with all of the information required to produce materials which will possess the uniformity and special features which we need. The information provided is not overly technical or complicated, but is stated so that it can be clearly understood by people in the corrugated board industry. We feel that the information is sufficient and practical and will not place any undue burden on the supplier.

Similar case specifications are used by the plants receiving the materials to determine by means of inspection and testing whether or not the material is rejectable or acceptable.

Corrugated case specifications show:

1. Compression and board strength limits to meet the requirements of Rule 41 and Package 215 of Uniform Freight Classification 4.
2. Inside case dimensions with the allowed plus and minus tolerance for length, width, and depth.
3. Flute style—A or C.
4. Construction—Regular slotted containers. Vertical or horizontal construction.
5. Material—kraft or cylinder board.
6. Flaps—outer flap butting tolerance.
7. Printing—all printing factors plus color standards.
8. Type of joint—stitched, glued, or taped.
9. Selective eye mark locations.
10. Bundling or packaging instructions.

Establishing specifications for corrugated shipping containers is governed by the following factors:

1. Uniform Freight Classification 4, ratings, rules, and regulations.
2. The mean size of the product to be packaged.
3. Runability or use requirements.
4. The type of product to be packaged.
5. Location and size of special artwork and brand identification.

Prior to the establishment of Package 215, strength requirements of all of Scott's corrugated shipping containers were governed by Rule 41 of Uniform Freight Classification 4. Package 215 was established through the combined efforts of the Technical, Traffic, Purchasing, and Product Standards Departments of Scott Paper Co. and through the assistance of a competent packaging consultant and the Uniform Classification Committee.

Package 215, which allows the shipper to use 175-lb. test board for shipping containers, has saved Scott Paper Co. and other companies shipping similar products many thousands of dollars since it was established in 1949.

Minimum standards for top to bottom compression of our shipping cases are, in the most part, governed by Package 215 of Uniform Freight Classification 4. Simply, Package 215 states that if the weight of the load does not exceed 16 lb. per cu. ft. articles may be shipped in fiber boxes complying with requirements of Rule 41 for boxes testing no less than 175 lb. The two exceptions to this are: (1) maximum dimensions must not exceed 90 united in. and (2) gross weight must not exceed 75 lb.

These containers, when conditioned, must have a resistance of not less than 10 lb. per perimeter inch of the area under compression.

For example, a container which has these dimensions, 21 by 15 by $18^1/_4$ in. must be capable of withstanding a top to bottom load of 720 lb. (42 + 30 = 72 by 10 = 720 lb.). The value then is the standard minimum load for top to bottom compression. Should cases of

ROBERT T. HOLT, Materials Control Engineer, Scott Paper Co., Chester, Pa.

Slimes in Paper and Paperboard Manufacture

PLAYING TWENTY QUESTIONS with the problem of whether slime is animal, vegetable or mineral points up to the fact that in paper mill practice, the word "slime" is no longer restricted to microbiological growths.

To mill men, slimes are any of the slimy deposits which may appear, ranging in content from hydrated fines and true microbiological slimes through hydrated aluminum oxide gels and entrained pitch, iron, silica and calcareous substances.

Identification Critical

Obviously, any appearance of slime in a mill system calls for *positive identification* of its substance, and *action* to bring it under control.

In appearance, it is usually difficult to detect any real difference between slime caused by bacteriological growth and that produced by masses of wet, hydrated stock and inorganic gels. Laboratory analysis is necessary to provide the detailed information required for an expert to recommend the type of control program to be followed.

Variety of Analyses Needed

Nalco Field Service Men have the training and experience needed to deal quickly and effectively with paper mill slimes. They carry test equipment to analyze your system . . . not only for microbiological activity, but also for the many organic and inorganic elements that are part of most deposits. Supplementing their on-the-spot service is the Nalco Paper Process Laboratory, a service and research center equipped for the most exacting analysis work and for comprehensive research on every phase of pulp and paper mill slime control.

Prevention vs. Remedy

Keeping slimes from forming in mill systems with a preventive program has proved by far the most economical way to operate. Waiting for the appearance of slime before applying remedial treatment invites expensive time and quality losses, as well as higher treating costs.

Microbiological section of the Nalco Laboratories.

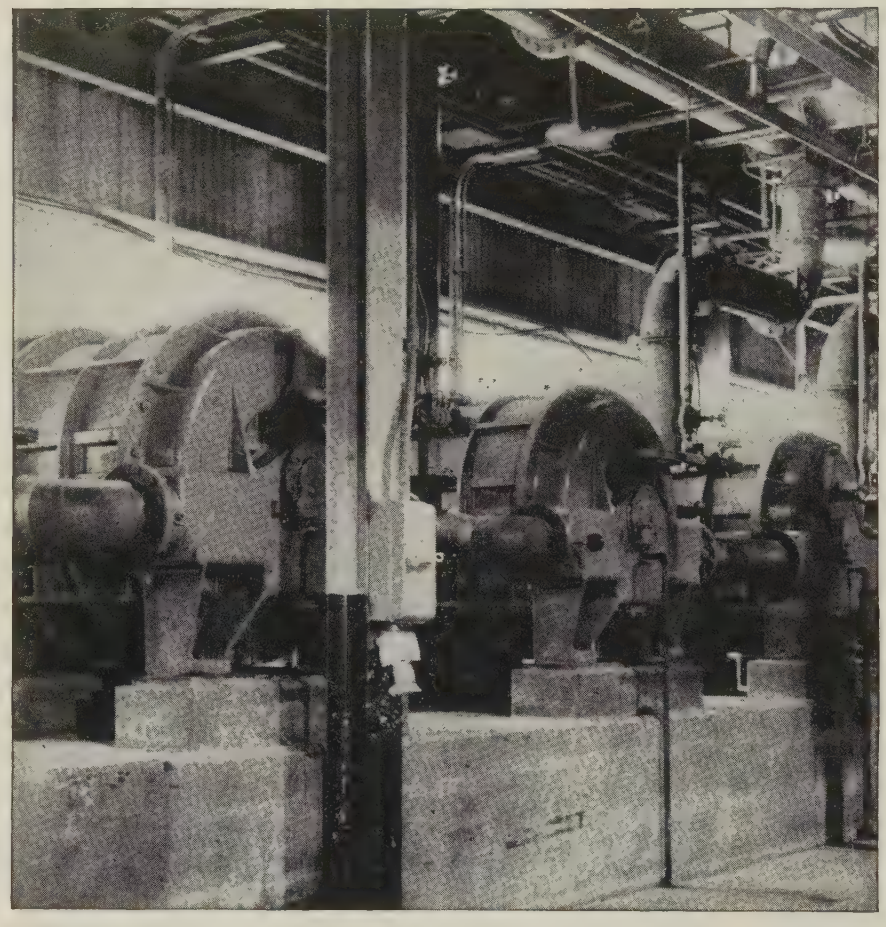
Nalco's Year 'Round Service

Seasonal variations in slime-forming conditions make effective slime control programs anything but static in nature. Your Nalco Representative is the man to put on the job to secure positive, low-cost slime *prevention*...all year long.

Call him—or write today for Nalco Bulletin P1.
National Aluminate Corporation, 6197 West 66th Place, Chicago 38, Illinois. Branches and affiliates in Canada, Germany, Italy and Spain.

Nalco CHEMICALS

What, actually, do Vacuum Pumps on paper machines handle?



Paper mill engineers know that it is actually a mixture of air and water vapor, but the custom of rating vacuum pumps in terms of air capacity alone causes this important fact to be frequently overlooked.

The presence of this water vapor causes a considerable reduction of the effective air handling capacity of any vacuum pump except the Nash. In the Nash Vacuum Pump the bulk of this water vapor is effectively condensed, due to the Nash operating principle. The air handling capacity of the Nash is therefore not reduced.

That is one of the reasons why Nash Vacuum Pumps are standard in over a thousand leading Paper Mills.

NASH ENGINEERING COMPANY

443 WILSON ROAD, SO. NORWALK, CONN.

this size test under 720 lb., the material is deemed rejectable. Frequently, however, cases of this size will test substantially higher than 720 lb.

In order to place more emphasis on compression values a performance rating plan was developed. After a reasonable number of tests have been made on a particular case, three ranges of values are established and classified as being marginal, good, and very good. The results of compression tests are recorded in one of the three categories and furnished to the supplier for every shipment which he makes.

Accurate and well defined printing can be equally as critical in our operation. The positioning of selective eye marks on a case cannot vary more than $\pm 1/8$ of an inch from the specified location if proper case selection and efficient traffic functions are to be expected.

The specifications for butting of flaps is probably unique in the industry, but there is a definite reason for it. Specifications state that outside flaps of the corrugated container must butt $3/4$ of an inch above the horizontal scores of the case. This insures us of complete closure when the case is sealed which prevents contamination from dust and other debris.

CASE SAMPLING AND PREPARATION PROCEDURE

The first phase of this segment in the quality inspection procedure is that of collecting representative samples of a manufacturer's run or a shipment. For several years now, due to volume increases and brand diversification, the company's case suppliers have provided our testing laboratory with these samples. Five knock down boxes which have been selected at random from the production run are bundled and shipped to the testing laboratory. Upon receipt of these samples, two cases are selected and prepared for inspection and testing. The samples are first conditioned in the hot room for a minimum of 8 hr. Humidity and temperature are controlled at 100°F. ± 5°, 30% ± 5% R.H. After this period they are conditioned for a minimum of 3 hr. at temperature and humidity conditions, controlled at 73°F. ± 3.5°, 48 to 52% R.H.

"How do I buy TiO_2? As mill superintendent, I have to O.K. orders for about 500 tons of TiO_2 yearly for our lightweight papers. I don't take chances—I specify Du Pont Ti-Pure*. Why? Because it's backed by a great service organization, is always high in quality and always delivered promptly. I hear Du Pont is expanding production facilities for 'Ti-Pure', too. That's another reason why I can count on a steady supply."

(Based on an actual conversation between a Du Pont Representative and a customer.)

▶Talked to *your* Du Pont Pigments Representative lately? He'll be glad to point out the "extras" you get with Du Pont "Ti-Pure" titanium dioxide pigments. Call him today! E. I. du Pont de Nemours & Co. (Inc.), Pigments Department, Wilmington 98, Delaware. In Canada: Du Pont of Canada Limited, P.O. Box 660, Montreal, Quebec.

*Du Pont's trademark for its titanium dioxide pigments

TI-PURE®
Titanium Dioxide Pigments

DU PONT
REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

This procedure expedites the conditioning of corrugated cases and also insures us that materials have reached equilibrium when exposed to TAPPI standard testing conditions.

RETEST PROCEDURES

Should any of the samples fail for compression or other factors during the inspection, 20 samples are selected at random from the load for retesting. If 5% of the "retest sample" fail to meet the established specifications the shipment is rejected.

Scott Paper Co. prefers and endeavors to make all retests in the presence of a representative of the supplier, especially if the retest is for a compression or bursting strength failure.

ROUTINE TESTING PROCEDURE

The case testing procedure is not complicated or difficult and requires only a few minutes time for each sample. Results of testing are recorded on test report forms divided into six general categories. These categories are:

1. General information.
   a. Testing date.
   b. Name of the manufacturer.
   c. Brand or case number.
   d. Manufacturer's code date.
   e. Shipping destination.
   f. Shipping point.
2. Dimensional data and selective eye mark location.
3. Strength data.
   a. Top to bottom compression and bursting strength values.
4. Printing.
   a. Color and general quality of all printed matter.
5. Manufacturer's joint.
   a. Positioning and clinching of staples, or the application and adhesion of glue.
6. Butting of flaps.

The testing sequence begins with the physical characteristics of the case and is followed by the compression test and burst tests. The two pieces of standard testing equipment used are a National Forge compression tester and a Perkins jumbo Mullen tester.

Test reports are made out in triplicate and are distributed to the supplier, the plant receiving the shipment of material, and one for filing purposes.

Case performance is frequently checked in the production areas for erection and sealing. Similar checks are made in the shipping department and in our warehouses for handling and stacking performance.

THE SUPPLIER'S QUALITY EVALUATION

At the end of each quarter the Packaging Division collects and compiles all of the testing data which has been accumulated. With these data two reports are made and submitted to the Staff Purchasing Department. The first report is the "Case Supplier Totem Pole" which compares one supplier to the other. The second report is the "Case Supplier Evaluation Summary" and deals primarily with the quality of the material which each company is supplying.

In preparing the "Case Supplier Totem Pole" report, the various inspection categories are rated as being marginal, good, or very good. The rating is obtained by dividing the total number of marginal ratings a supplier has received by the total number of ratings received for the period.

The "Case Supplier Evaluation Summary" shows the three categories in which each supplier received the highest number of marginal ratings. Actually, the report lists the suppliers, shows the per cent marginal ratings and the categories in which they are consistently deficient.

Reports of this type are very beneficial to the Purchasing Department in securing materials of the highest quality for our consumption. They act as an aid to the supplier in pointing out those areas which require special attention. Similarly, the individual plants in the Scott circuit are aided by these reports which highlight certain qualities which some suppliers consistently manage to maintain.

SUMMARY

To recapitulate briefly on what I have related to you, Scott's approach is basically that of defining two very simple questions. (1) what do we have? and (2) what do we need?

The answer to the first is, we have a commodity which we desire to sell.

The answer to the second question is, we need a means of getting this commodity to the consumer in the best possible condition.

We have furnished the supplier with instructions so that he can provide us with what we need. We are measuring to be sure that we are getting what has been determined to be necessary. We are cooperating with our suppliers and they with us in an effort to constantly attempt to upgrade this vital material.

Quality begins at the point of manufacture and without the excellent programs which are carried out by case suppliers, our efforts would be futile. Possibly the attitude of cooperation which exists between the suppliers and Scott Paper Co. is the unknown quality control function which insures us of continued excellent performance.

How else could we boast these gains in our over-all operation?

1 Inadequate material usage is at a minimum.
2 Increased production by a reduction in down time and waste.
3 Greater protection to our products which means increased quantity and better quality.

Presented at the 44th Annual Meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 23–26, 1959.

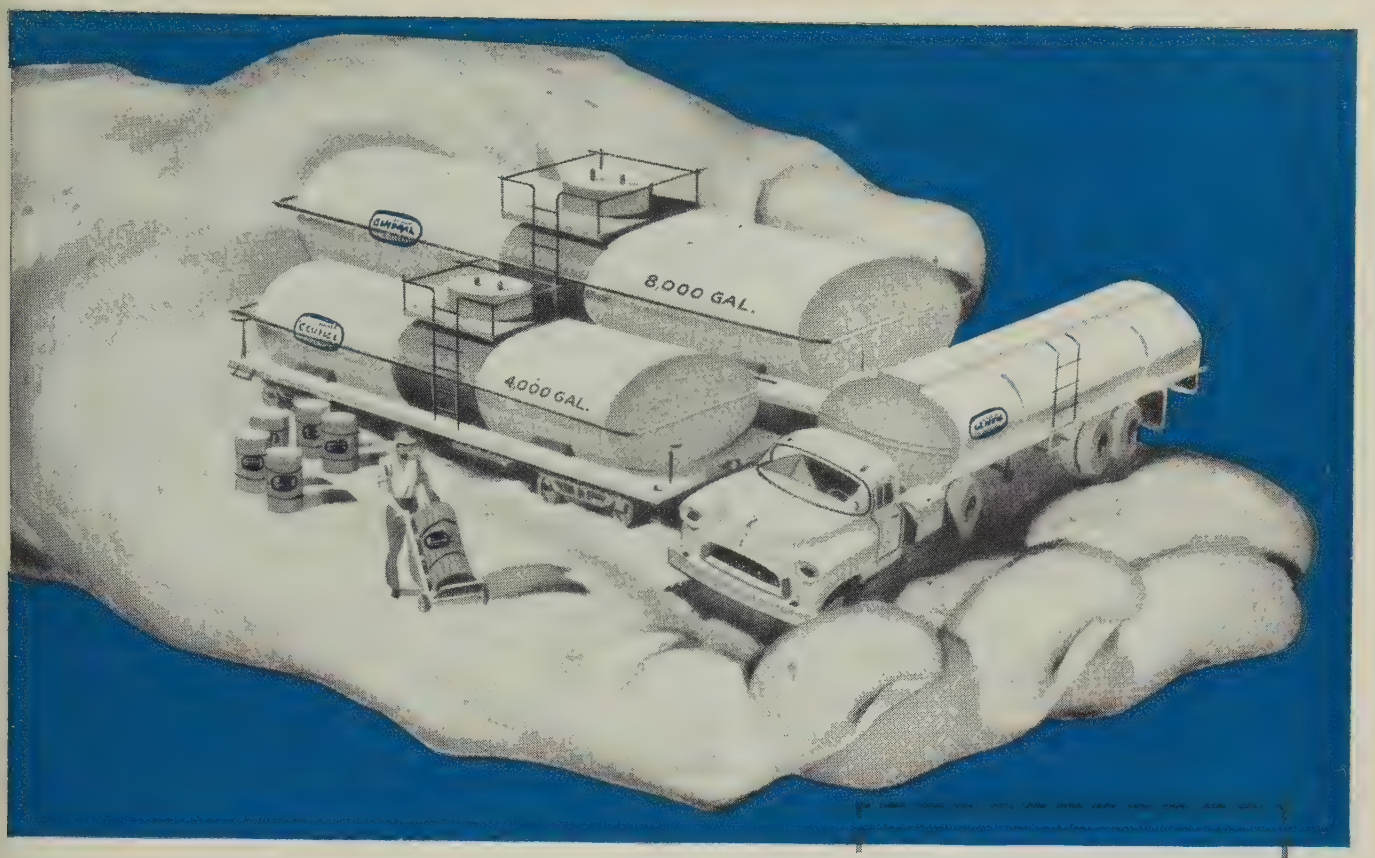
Tenth

Coating Conference

TAPPI

Statler Hotel, Boston, Mass.

May 25–27, 1959



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To help you keep latex inventories within reasonable limits, Gen-Flo is available in shipments tailored to fit *your* production requirements. Whether your need is for drum, tank truck, or tank car quantities, Gen-Flo is ready to serve you now!

Gen-Flo, the "balance-controlled" styrene-butadiene latex, comes from an ultra-modern plant, where it is carefully produced and thoroughly tested by skilled technicians to assure the ultimate in quality and uniformity. Prove Gen-Flo's excellence in your own starch or casein paper-coating formulations—write today for literature and a generous sample of Gen-Flo . . . the latex that *makes* outstanding paper.

FACTS YOU SHOULD KNOW ABOUT GEN-FLO

Tested by leading manufacturers, Gen-Flo has been found to offer these advantages for paper-coating applications:

- Superior brightness
- Better pick resistance
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CHEMICAL DIVISION
AKRON, OHIO

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A Complete Starch Line... *tailor-made to your needs*

Today's complex papermaking operations require a wide range of starches—starches specifically designed to do a particular job. You'll find that the complete starch line offered by Corn Products Company includes types for every phase of modern papermaking. These starches are available in so many varieties that *they can literally be tailor-made to suit individual requirements* and production problems of individual plants!

For example, in beater sizing, preferred starches for improved surface qualities plus excellent bursting and tensile strength, include the many varieties of Globe and pre-cooked Amijel. For calendar sizing, you'll find a complete line of Claro and Eagle starches, as well as Globe starches for enzyme conversion. In this operation, Globe and Excello dextrines and thin-boiling Foxhead starches are also used. For general coating, with good viscosity at high solids content, use Claro and new improved Ten-O-Film starches.

And the research staff of Corn Products Company, largest in the industry, is constantly at work developing new products to meet the changing needs of modern papermaking.

Our technical representatives are completely versed in the problems that arise with wet end additives. Their impressive field experience and continuing research into starch, evidenced by frequent publications in trade and technical journals*, is always at your service. Take full advantage of the facilities and experience of the world's largest corn processors—call our nearest sales office or write direct.

Fine products for the Paper Industry: GLOBE® • EAGLE® • FOXHEAD® • CLARO® • AMIJEL® CORAGUM® • TEN-O-FILM® starches • GLOBE® • EXCELLO® • LAM-O-DEX® dextrines and gums.

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*A reprint on the results of corn starch usage is available on request from our New York office.

DRAMATIC MOMENTS IN PAPER-MAKING PROGRESS

Aubrey Crabtree, President of Fraser Paper, Ltd., and Mill Manager J.W.D. Hierlihy are shown here "center stage" in one of the paper industry's most exciting events—the first run of a newly rebuilt machine. In their hands is paper produced by their Fourdrinier machine, which was completely rebuilt by Pusey and Jones and is now in service at Fraser's Madawaska, Maine, mill.

It has a completely new Fourdrinier, a 228" wire width, 100' 0" wire length, 2000 fpm speed, and was preassembled at the Pusey and Jones plant for faster installation and on-time start-up. A vacuum pickup arrangement and an after-dryer section with completely enclosed gearing were added.

Pusey and Jones, the first company in the United States to specialize in the manufacture of paper-making machinery, continues to pioneer with such developments as the Automatic Air Guide System® and a new Differential Hydraulic Drive. May we help you with a complete machine or a component specially designed for your needs?

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- Application help for you or your consultants.
- Undivided responsibility for performance.
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And, of course, having only one supplier eliminates the many conference hours, the complications of delivery and installation scheduling, the phone calls, telegrams and voluminous correspondence associated with buying from a combination of suppliers.

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Centrifugal pumps, rotary compressors, motors, control, *Texrope* drive equipment, screens, slakers, kilns, turbine-generators, condensers, switchgear, water conditioning equipment, materials handling equipment.

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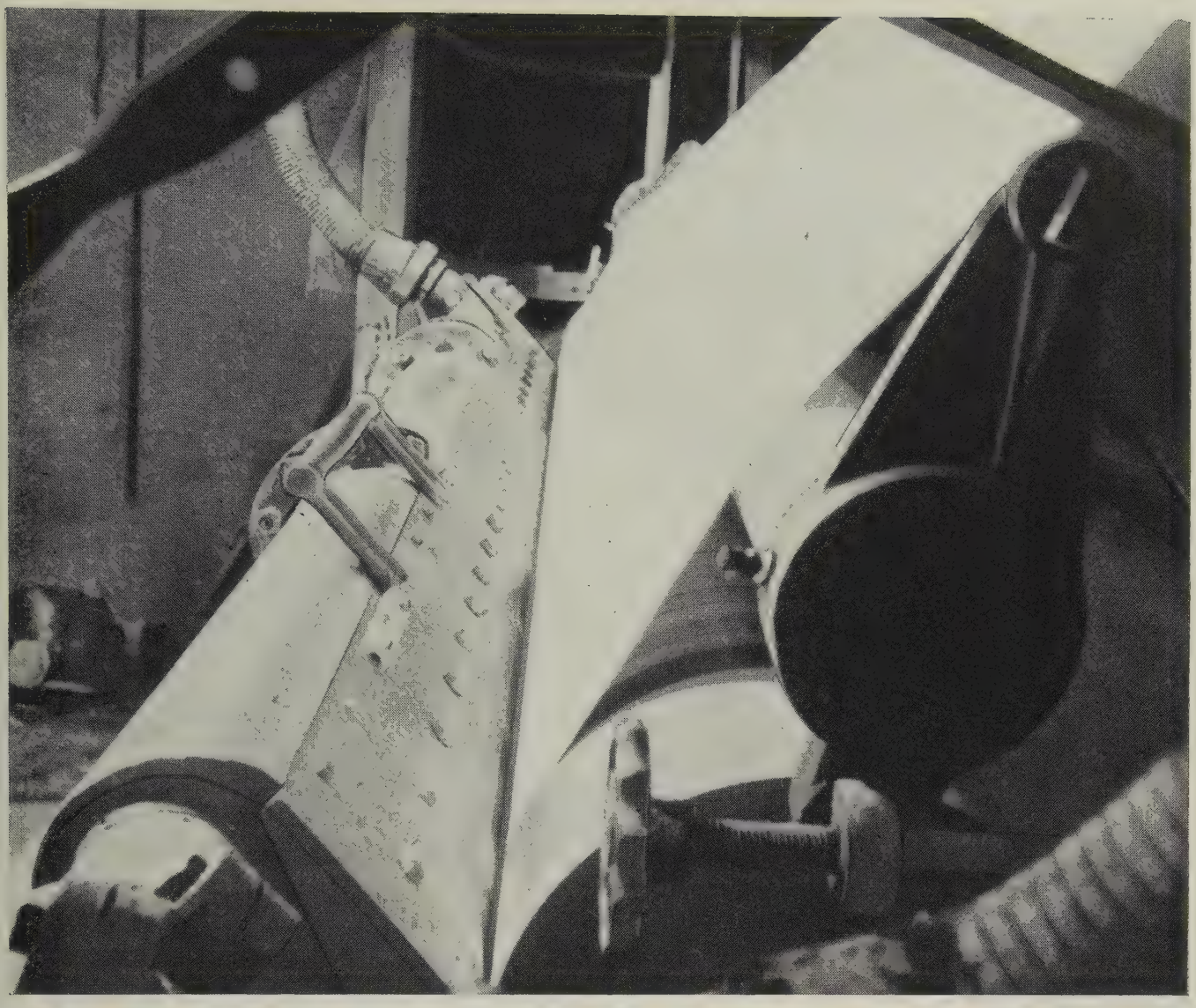

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Calgon leads because it provides . . .

Better pigment dispersion. Calgon has high efficiency as a dispersive of clay, titanium dioxide, precipitated calcium carbonate and other pigments.

Better coating colors. With Calgon in the formula, flow properties are improved and higher solids concentration can be used.

Better surface coating. Adding Calgon to the coating formula greatly improves the bond between the coating and the paper stock.

Calgon can help in many other ways. If you have a specific problem, Calgon Technical Service will be glad to assist you in finding a solution. Let us know about your problem, or write for a copy of "Calgon and Its Applications in the Pulp and Paper Industry."

*Calgon is the registered trademark of Calgon, Inc. for its sodium phosphate glass (sodium hexametaphosphate) products.

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Another Stebbins First–

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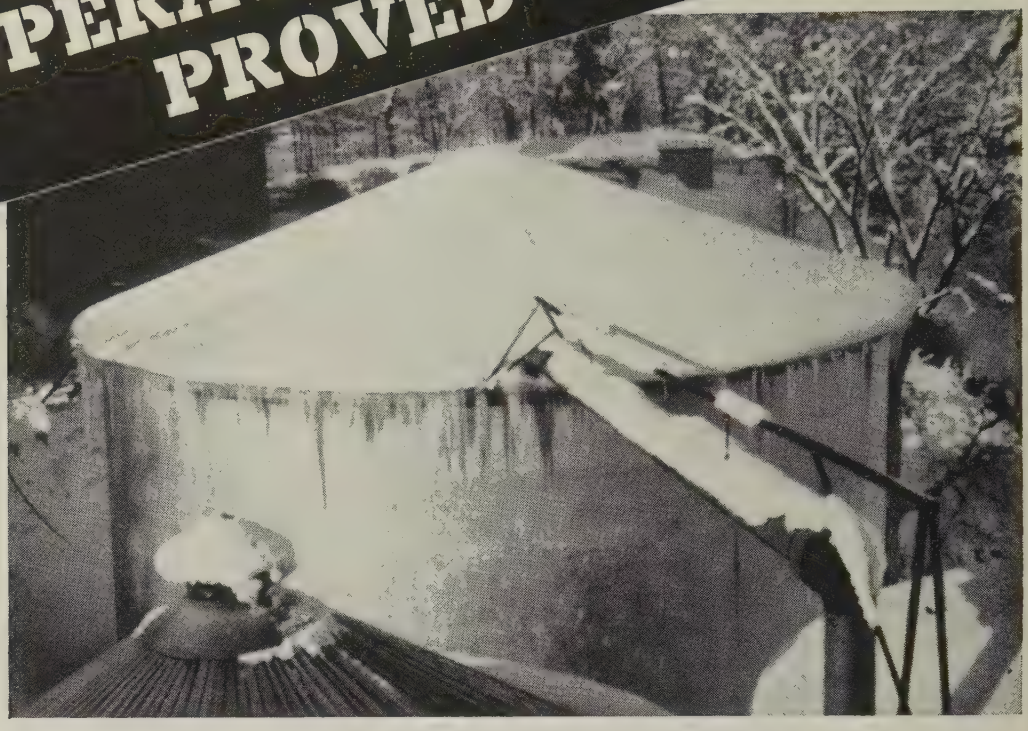

Insulated Ceramic-Concrete Outdoor Tanks for Sub-Freezing Climates

The tank illustrated, located near the Canadian border, has been through two winters carrying stock at 4% consistency. With no addition of heat, there has been no freezing—no adherence to the inner walls.

Perfect for outdoor storage of acids, liquor and pulp slurries in locations where extreme temperature changes are commonplace, Stebbins insulated tanks conserve heat, decrease the hazard of freezing and provide more uniform liquor and stock temperatures for operations. Cost compares with that of insulated steel, wood stave and other materials, AND—the interior surface can be of tile or brick with proper joint material for full corrosion resistance.

Conserve valuable inside space and still prevent expensive maintenance due to stock freeze-ups. Specify a Stebbins insulated tank. Complete on your foundation ready for use, with concrete cover or open for your own cover. Wooden covers can be supplied by a Stebbins subcontractor. Write for full details.

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Specialists in Design Installation and Servicing of Linings and Tile Tanks

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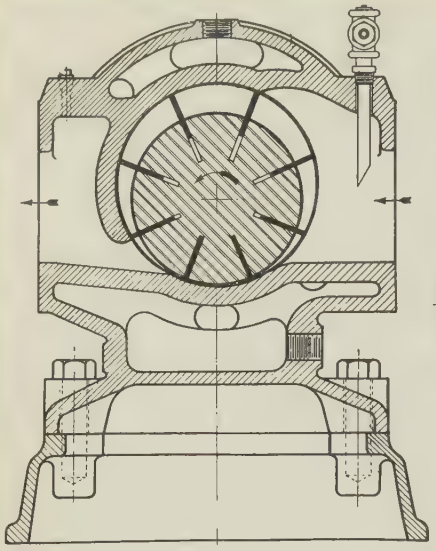

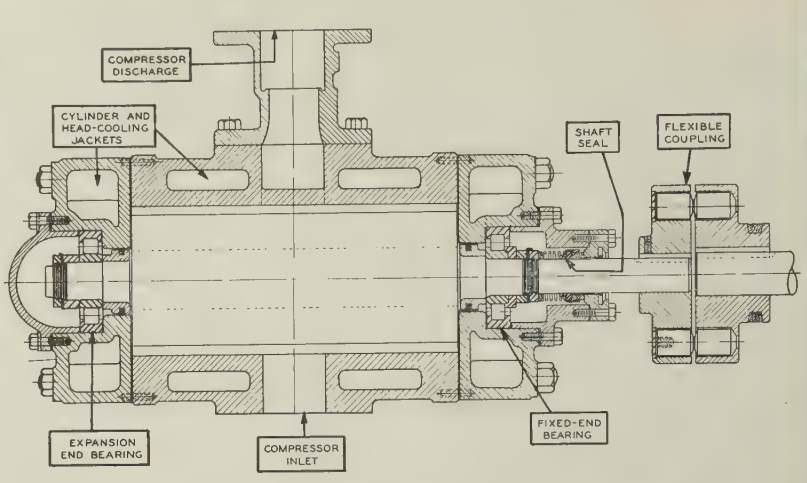

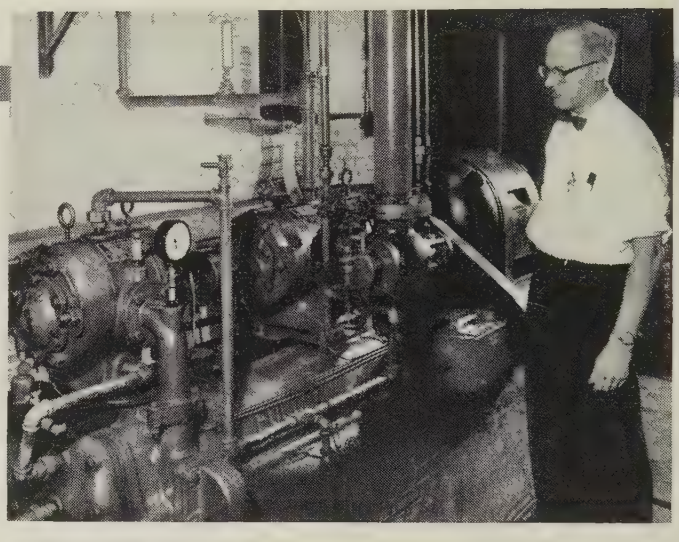

Hard service never affected this Fuller rotary's original output—230 cfm. of air at 90 lb. G., reports Mr. Schott, chief engineer, Thomas C. Wilson, Inc., Long Island City, N.Y.

FULLER ROTARY COMPRESSOR RUNS 13 YEARS WITHOUT DOWNTIME

A Fuller rotary at Thomas C. Wilson, Inc. got its first maintenance shutdown recently, for renewal of roller bearings and rotor vanes—after running without downtime since 1945.

4 years of 24-hour service. The Wilson plant makes tube cleaning equipment, tube expanders and portable pneumatic tools, and so makes heavy daily demands on shop air. For the first four years, three-shift operation kept the Fuller rotary running round the clock. Since 1949, it's been working eight-hour shifts.

Simple design means trouble-free service. Besides bearings, the only moving parts in a Fuller vane-type rotary compressor are the cylinderical rotor and the blades. These compensate for wear automatically. Cylinder head slips off, permitting blade and bearing inspection in a matter of minutes.

Compact and vibration-free. Direct-drive system saves space. Simple, rugged design gives constant service without extensive supervision. Thus, Fuller rotaries can be installed out-of-the-way—on upper floor, on balconies, in basement corners, using low-cost, light-weight foundations.

1189
C-340

Write today for detailed information on the full line of Fuller rotary compressors for in-plant services, gas gathering, and industrial refrigeration.

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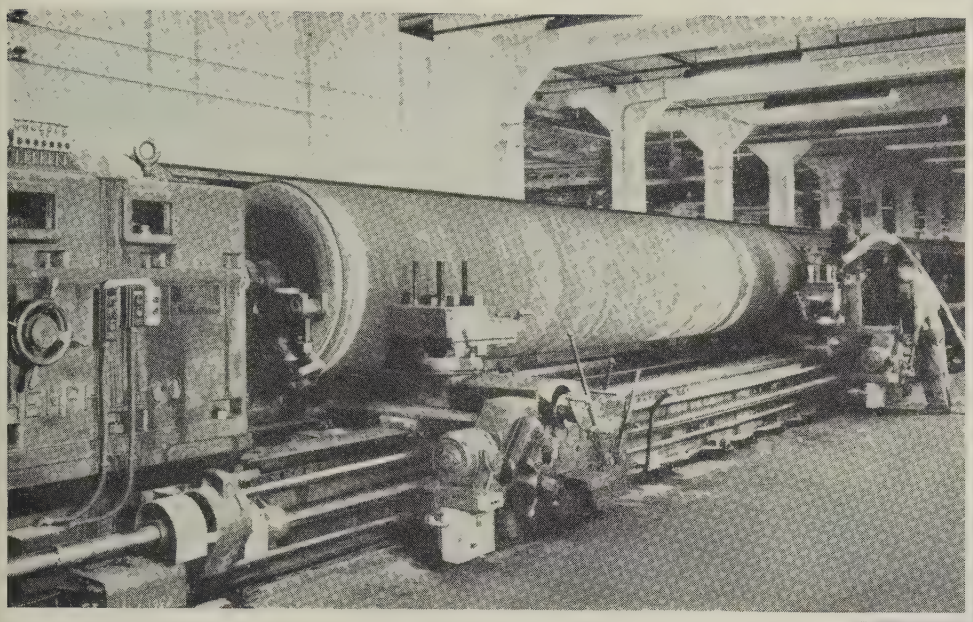
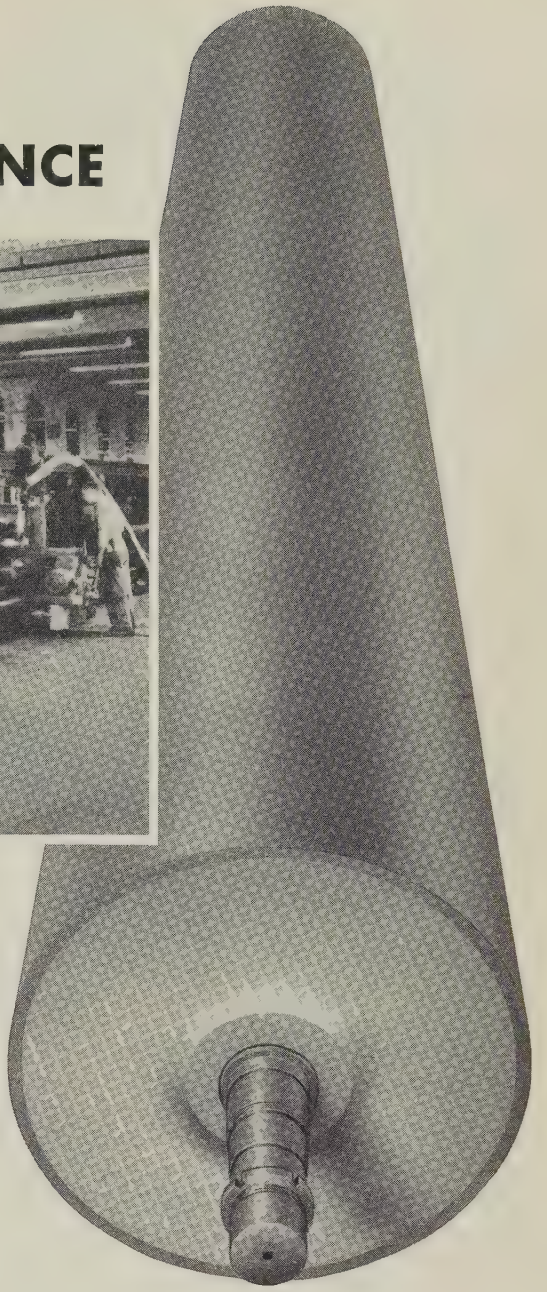
PIONEERS OF HIGH-EFFICIENCY VANE TYPE ROTARY COMPRESSORS SINCE 1930

LOOK TO THE COVER
FOR BEST ROLL PERFORMANCE



One of five suction press rolls in preparation, each 30 feet long and 50 inches in diameter, rubber covered by Manhattan for the world's largest paper machine, located in Canada.



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Testing Machines Available for Quality Control

W. F. BACHELDER

THE hand, with nothing in it, was the original quality control device. It is simple to use, needs no maintenance, will last a life time, and needs to be oiled only every now and then.

Actually many of you, to this day, depend upon feel to a great extent in the quality control of your products. Certain men I have known can tell, with an amazing accuracy, the thickness of a sheet of paper just by holding it between two fingers. As good as this may be, it is not precise. The need for more accurate measurement is known to all of you and therefore as a substitute for our hands, we now use instruments.

Imagine, if you will, that I have in my hand a surgical scalpel. It is made from the best steel and honed to the highest degree. It is, however, only a tool—useless without the skill of the surgeon who, with the scalpel, can perform miracles.

It is the same with the instrument manufacturers in your industry. You are the doctor who uses the equipment, who creates the techniques, and who benefits most from the products we supply.

We depend on you to point out shortcomings of the equipment, as well as improvements, We, in turn, do our best to supply equipment which conforms to methods you develop.

Today, I would like to invite your attention to certain instruments for quality control. My discussion will cover testing machines made by many different companies in many different countries. It is impossible to even scratch the surface. We have classified our assortment of testing machines into nine classifications. These range alphabetically from abrasion testers to wax testers.

In some cases there are nearly one hundred instruments in a category. So you see that it is impossible to cover them all, and if I leave out an instrument which you feel should have been included, it is only for lack of time.

It is very possible that some of us do not realize the wide variety of instruments available and are not aware of the developments in other countries, or the recent modifications and improvements to existing instruments. The border line between routine control, spot checks, and research is not always clearly defined.

To some folks an instrument that is used for quality control is the same unit someone else uses for research. So, if I mention a testing machine you don't use, it is most likely used by someone else in the industry and therefore, should still be of interest to you.

Consider abrasion testers. There are at least 18 different abrasion testers. Some of these can be adapted for paper and corrugated materials. Three of those which are of considerable interest and first—the Taber Abraser, a revolving disk-type instrument with calibrated abrasive wheels. Secondly, the Sutherland rub test which is becoming increasingly popular in the paper field and third, the various types of scuff testers. It is safe to say that in this field there is a singular lack of standardization. Each instrument has developed its own peculiarities. Modifications of other units which were designed for films, impregnated cloth, and so forth have all been used at one time or another. There seems to be a large field for improvement in this particular category.

When it comes to bursting testers, we can have a field day. Perhaps some of you know what I have in my hand. It is a long extinct portable bursting tester called a Webb tester. From this little unit we go to other portable types, generally not suitable for corrugated board, into the Mullen tester category. Mullen testers have had a long history and are a never ending topic of discussion in TAPPI meetings. Modifications of the diaphragm, improvement in the loading system, and improvement in the gages, have all occurred over the years. In principle though, the Mullen tester is much the same as when first developed. While we are presently giving consideration to the height of distention of the diaphragm in America, this factor has been under closer scrutiny in Europe. Indeed, there are bursting testers which not only give the bursting strength of the material but also indicate the height of distention at time of burst. It is very possible that in this country we should give more thought to including the height of distention in the bursting test. In addition to the fluid-type bursting testers there are compressed air units operating on much the same principle. They are very popular in other countries.

Closely aligned to the bursting tester is the dynamic burst or puncture tester. For certain high strength materials the puncture tester is more adaptable than the flexible diaphragm-type instrument. This is particularly true for extremely strong hardboard and triple wall corrugated. The Union of South Africa has adopted the puncture tester as a standard government specification for corrugated.

Another dynamic burst tester is the Frag tester, recently developed in Austria. This device exerts a series of blows by dropping a constant amount and weight of steel balls against the sample until rupture. In theory this device can predict the ultimate resistance to rupture in bags and sacks and other types of packaging material. While it is not yet a generally accepted quality control instrument in this country, there are some plants having three or four of these units.

There have been some interesting adaptations of the Mullen bursting tester. One of these is a tensile strength attachment which was developed in Canada and is sometimes used for determining the directional tensile strength of newsprint. There is also a nail pulling attachment which adds another function to the

W. F. BACHELDER, President, Testing Machines, Inc., Mineola, L. I., N. Y.

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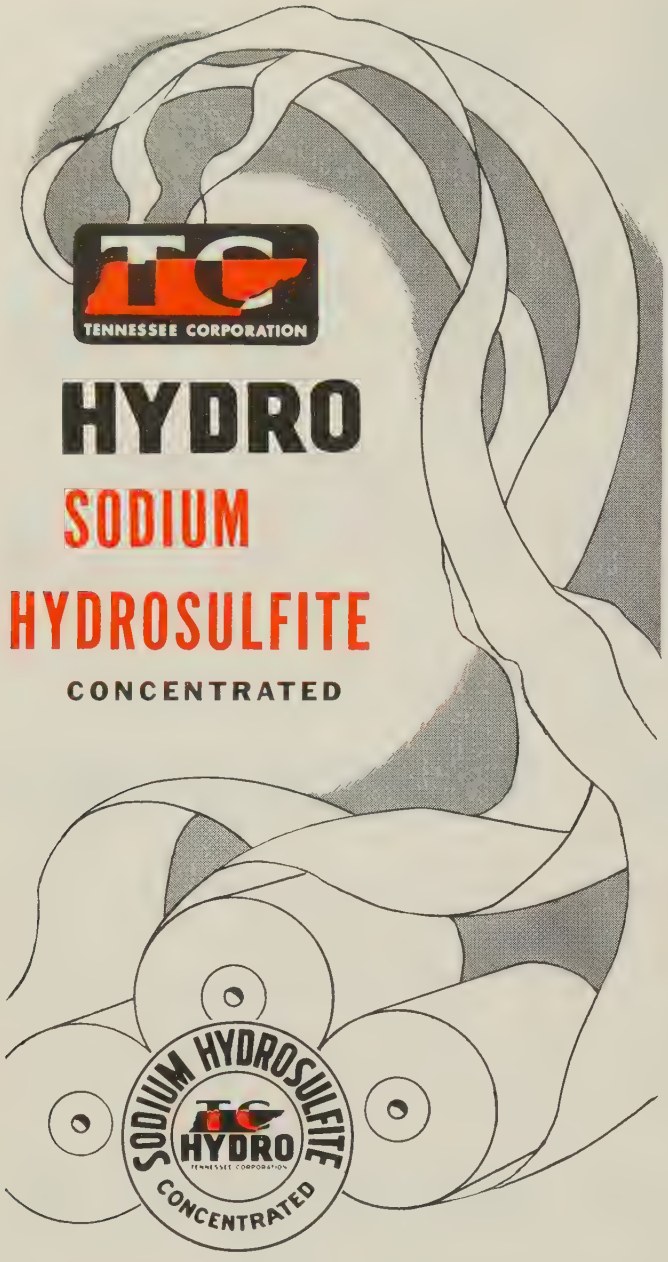

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basic unit. The Mullen tester also can be adapted for crush testing. I will discuss this a little later. In conclusion about the bursting tester may I state that it seems that puncture or burst resistance is of great consideration. Perhaps this is due to the treatment which the material is doomed to receive in actual usage. If this is true, it can safely be said that some type of puncture resistance measuring device will be an item of quality control for years to come.

The field of compression testing is perhaps the most all inclusive area and the one which incorporates the most tests.

Let us take first the flat crush test for combined board. This test was made in a variety of ways prior to about 15 years ago. At that time there was developed what is now known as the Hinde & Dauch flat crush tester. This incorporates the crushing of a flat sample of a specified area. Shortly after the H & D tester was developed, there was another tester made available, which is called the Blum tester. This performs a flat crush but the sample is not cut prior to the test. The two tests are not comparable in results, and the H & D test is far more widely used than the Blum at the present time. In making the flat crush test it has been found that the rate of loading is of prime importance in determining the test results. Because of this, great care should always be used in reporting test results. It is our belief that the rate of loading should always be specified in the case of the H & D test where the rate of loading is dependent on the capacity of the deflection bar as well as the platen speed, and both factors should always be referred to. It is this question of rate of loading which should be considered before using the Mullen tester attachment for crush tests which I mentioned previously.

In order to have a more versatile instrument it is desirable to have a variable speed machine. The National Forge 1000-lb. compression tester was developed to give this variable speed which permits altering the rate of loading. It can be fitted with a recorder to graphically show the yield pattern, if desired.

It is possible to crush a flat sample in several different ways by means of those instruments or a compression cage on a tensile tester can be used. The great difficulty in many of the modified units is that they are so hard to use and the question of rate of loading is ever present, thus tending to confuse the correlation of test results.

In addition to the flat crush test, the compression tester can be used for several other tests. The ring stiffness test is one example. The H & D tester is particularly adaptable to this test although as with the flat crush test, other instruments can also be used.

The pin or ply adhesion test is another test which is used for quality control which has developed over the years in several different ways. One of the original specimen sizes and methods was outlined by The Institute of Paper Chemistry. This method pulls against both the liners at the same time. It is sometimes felt that because of this dual stress function it lacks the ability to determine the quality of one particular gluing operation. Hence, there have been modifications of the pin adhesion attachments so that only one liner is pulled away from the corrugating medium.

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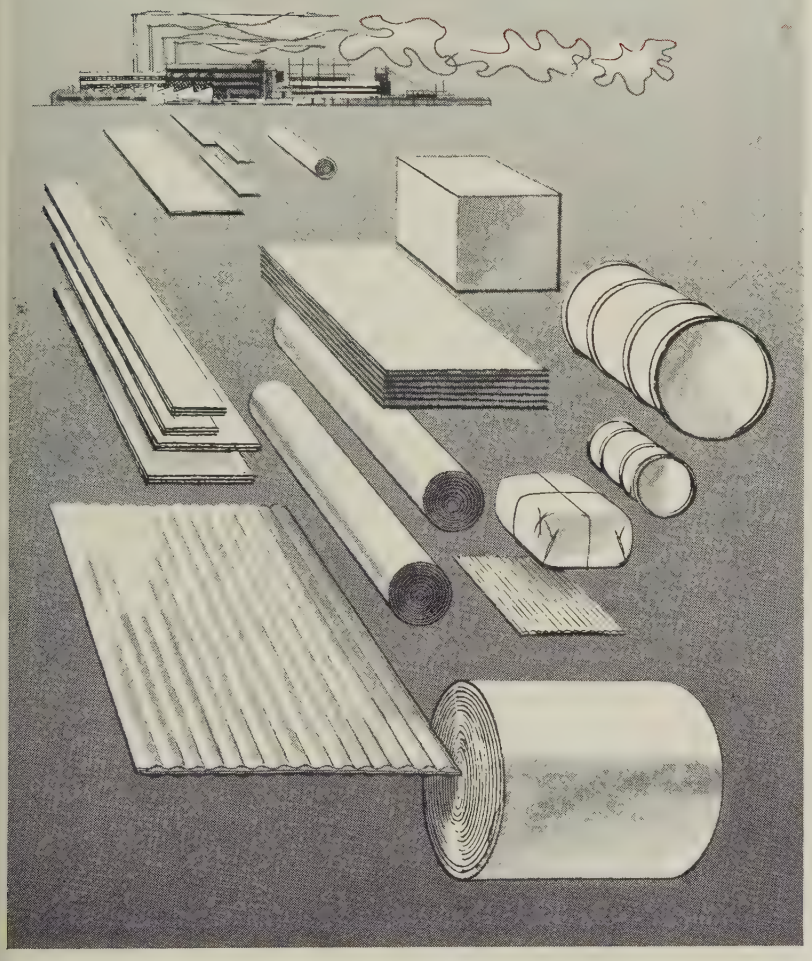

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Another test which can be made on the compression testers is the Bathurst manufacturer's joint test. This particular attachment is adaptable to either the large capacity floor model compression machines or the smaller 100-lb. National Forge type machine.

The Bathurst attachment, in essence, makes a tensile test of the manufacturer's joint. The attachment can also be used for pulling apart glued sections of the combined board. The Bathurst manufacturer's joint attachment is a new idea and as yet has not received extremely wide acceptance although there are many firms who do attach great importance to this test.

The column compression test can be made on the H & D, National Forge, and some of the larger compression testers. This test, which consists of placing pressure endwise on a sample of corrugated material, is not too widely used but it seems to have considerable merit in determining the strength of triple wall board. Because of its apparent value in the higher strength materials, it is generally necessary to have an instrument of at least 1000 lb. capacity.

In addition to the common tests, several other tests can be made with compression tester such as screw withdrawal or cleet withdrawal tests. Tension adapter cages can be used with those testers having a large opening. By use of the cage, tensile tests can be made on a compression tester. Nail pulling fixtures and puncture attachments are also possible.

It seems as though no complete laboratory should be without a compression tester of some type. With the exception of compression cages on tensile testers, most of the compression testers are dead-weight or lever operated instruments. The Concora corrugating medium tester and laboratory corrugators in general are sometimes used in conjunction with a compression tester in an effort to predict the quality of the finished product.

Before tests can be made on most instruments, there must be a sample preparation. It is our belief that many times this important aspect of the test is overlooked. The simplest device for sample preparation, of course, is a pair of scissors. When using scissors for making ring crush samples, considerable error can be introduced in the results because a thousandth of an inch out of parallel will give an error in the test.

From the scissors you can proceed to various types of cutting or trimming boards. These vary in accuracy and preciseness, usually according to price, and it is sometimes a great mistake to try to save money in this regard. From the trimming board we can proceed to the heavy duty special purpose trimming boards which will cut an accurate square foot sample. This sample is used for basis weight as well as for moisture determination in many cases. These heavy duty four sided cutters save considerable time and assure accuracy of results. They securely hold the sample and accurately rotate it 90° for each cut. On a recent trip through a large mill, I saw ten or twelve of those units stationed throughout the mill. Although they merely prepare a 1 sq. ft. sample, it was felt that the accuracy of the sample warranted investment in these relatively expensive heavy duty cutters.

From the single blade cutter we can proceed to the double blade cutter which is a distinct step forward when parallelism of the edge of the strip is required. This is the case for tensile tests, ring crush tests, Elmendorf tearing tests, and folding endurance tests. However, they do not usually cut the sample to length and hence, they actually require two cutting motions. They are quick and easy to use, however, and the operator cannot influence the width of the sample, although care must be taken to insure proper orientation of the fibers.

From the double bladed cutter we proceed to the die-type cutter where all four sides are accurately determined and cut in one operation. It is interesting to note, however, that there is always room for improvement and on the National Forge type die cutter we have been asked to add a guide device so the operator can accurately align the sample being cut and control fiber orientation between samples. This guide is simple and can be made and added by yourself but it is a factor to consider if you are presently using a die-type cutter.

There is also a cutter available for removing a circular sample from a moving web of paper. This is particularly useful in obtaining samples for moisture determination.

Once again may I urge you not to overlook the importance of proper specimen preparation. A poor specimen can negate all the care and effort put into testing on an expensive machine.

The drop tester is another interesting piece of equipment which "developed like Topsey and just grew." The most common type is the so-called Acme drop tester, consisting of two flat panels on which the sample is oriented and dropped by a release mechanism. There is a model of this style which incorporates a solenoid release so that the operator can have both hands free to hold and orient the sample.

There is another version of the same tester which holds the package from beneath in a single arm which is suddenly withdrawn allowing the container to drop freely. On packages or containers over approximately 100 lb. it is often necessary to use a sling with an instant release hook. The procedure here is to raise the package by block and tackle up to a predetermined height and then the package is instantly released. The drop testers' value is empirical and the method of operation should be carefully understood between any parties involved.

In a similar category is the revolving drum tester which, while standardized to a considerable degree, still gives comparative results only. We have had requests upon occasion to manufacture a drum tester smaller than the standard 7-ft. size, but it does not appear to us that this unit will reach any popularity or that the drum test itself will be considered a precise testing tool.

While discussing the testing of completed containers such as is generally done on the drop and drum it would perhaps be appropriate to mention at this time the large floor model compression testers. There seems to be considerable interest in the testing of completed containers and many firms incorporate this test in a quality control program. While 10,000 lb. is commonly thought of as being sufficient for testing completed containers there are machines available which will perform tests at considerably higher ranges.

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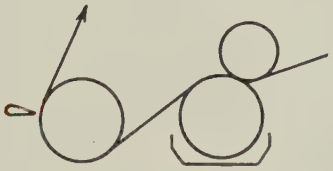
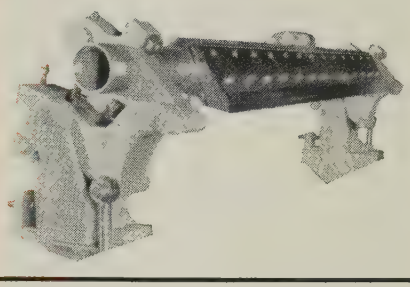


AIR DOCTOR



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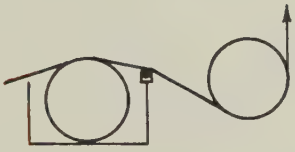

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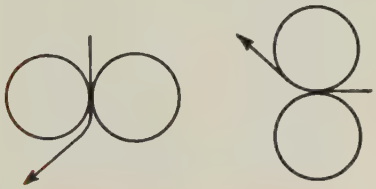

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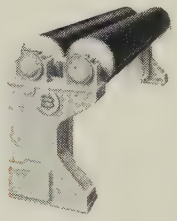

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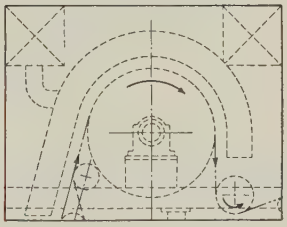
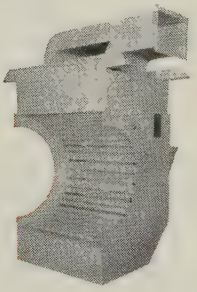


HIGH VELOCITY AIR DRYER



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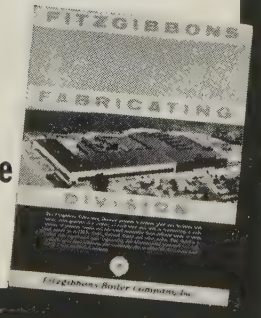

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There are compression machines which have variable speeds so that the question of rate of loading, if it should arise at a future date, is well taken care of. In addition, there are units which have visual and audible indicating systems to eliminate the need for preparing charts for every test. Also available is a constant load device which presumably will duplicate stacking tests. As far as we know, all the available machines have versions for both floating and fixed upper plates.

For certain users of containers the interior size measurement is of considerable importance. The industry finds itself in the position of not knowing exactly how to measure the inside of a box. The obvious way, of course, is with a ruler but if you practice this procedure for very long you will find that it is fraught with difficulties.

In an effort to simplify the matter, Mr. Gross of Union Bag-Camp Paper Corp. developed a device by means of which it is relatively easy to take the interior measurements. Another device was recently developed by Mr. Frazer of the Nashua Corp. which allows the interior measurements to be taken by measuring only the outside of the box. This has some advantages over the Union Bag type of measuring device but does not solve all the problems. To the best of our knowledge those are the only two devices available at present to allow the uniform inside measurement on containers.

A device has been invented in England called the P.A.T.R.A. carton crease gage. It allows the most precise measurement from score to score as well as the depth of the score. It incorporates the casting of a shadow and the measurement by means of a microscope. The unit was designed specifically for folding cartons but I thought I would mention it at this time.

Another tester which is used for testing the completed containers is the incline impact tester, commonly known as the Conbur tester. Many of these units have been custom made by the user but there are at least two versions commercially available. Standardization of the incline impact tester is of prime importance and in this regard some type of impact recording device is necessary. The impact register is a device widely used by the railroads and when introduced into the laboratory can be used for determining equivalent shock on your laboratory equipment. The three way Impact-O-Graph, records shocks received from three directions and certain models of this device are relatively inexpensive and can be used in conjunction with drop, vibration, and impact testing. We feel, however, that none of the mechanical units can perform as well as the electronic shock recording devices. There is, however, little comparison in price and ease of operation. The question of shock measurement, G readings, and allied subject matter is extremely complicated and great care must be taken at each stage of the testing program to assure comparability and accuracy.

As most all of you are closely concerned with gummed tape, I might mention at this time that internal bonding strength of gummed tape and other materials is becoming increasingly important. Originally, the bond adhesion of materials was tested on a tensile tester from a split sample but the internal bond tester developed by the American Sisalkraft Co. seems to be an advance over that method. Its use, however, as a quality control instrument has not been firmly established up to the present time.

At the beginning of this talk the original thickness measurement device was mentioned as being two fingers. From there we went to a mechanics threaded spindle micrometer, and many years ago we progressed to the dial-type direct reading micrometers.

The dead-weight dial type micrometer was introduced in an effort to overcome the variables of spring tensions, but it has recently been found that dead weight micrometers can be influenced by the method of operation. Dropping of the dead weight can make a distinct difference in the test. From one height of drop to another height will give different results. As a result of this the motor operated micrometer was introduced. It goes a long way toward

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solving the variable factors due to the human element. Tests can now be made without the operator touching the instrument.

Readings to 0.001 and 0.0001 in. have become commonplace. There is now a micrometer available which reads in 0.00001-in. divisions by means of a vernier.

A new and interesting development from Denmark is the Arkas profile tester. This instrument, which can be used by unskilled operators, measures, and records the thickness of a strip of paper which has been torn across the roll from one edge to the other. This device eliminates the need for carrying samples to the laboratory and greatly speeds up making a series of tests across the width of the roll. At the present time, thickness is becoming increasingly important. Certain isotopes have been incorporated in continuous reading indicating equipment to give equivalent thickness readings. These instruments are, in essence, instruments which record mass as opposed to thickness and as yet there is not a completely satisfactory continuous reading micrometer.

The testing for mositure is very common and for this test we have the oven and balance type as well as several electronic types. The oven and balance types sometimes incorporate both the oven with the balance, such as in the Williams unit and the new O'Haus meter. In these units a 10-g. sample is taken and the moisture percentage is read directly without any further contact with the sample.

Many firms, however, use a plain laboratory oven and then weigh the sample separately. This involves the risk of regain of moisture and is relatively time consuming.

The electronic moisture meters, such as the Hart and the Marconi, give instantaneous readings and can be used right along side of your production equipment. Special calibrations are required in most cases for different materials. This is considered by some to be objectionable. When properly calibrated and operated, however, we feel these electronic micrometers are ominently satisfactory.

There is a wide choice in choosing a scale for determining basis weight. The slowest, and the one requiring calculations, is the use of an analytical balance. A much faster way is to use the quadrant-type direct reading scale which, by placing a sample in the basket, you automatically obtain the reading of a larger area. An example of this is the weighing of a square foot sample to obtain directly the weight of a thousand square feet. A more precise scale, than the desk quadrant type, is the Thwing wall-type scale, or the Toledo scale.

In any weighing operation great care is required. Some prefer to incorporate "go"–"no-go" arrangement on their scales which eliminates the need for close reading or calculation. We have supplied quadrants with green and red areas indicating suitable or not suitable basis weights.

A relatively new development in the testing of containers is the score bend or opening resistance testers. An example of this is the Ohio Boxboard instrument, which measures not only the opening force required for a folding carton but also the force necessary to determine score bending of the flap. For measuring the bending of the flap alone there is the HBC score bend tester, which indicates the amount of the residual rigidity after a sample of 6 in. or less has been scored and bent through a 90° angle.

A new device for measuring the opening force alone is the TMI Hunter score bend tester which incorporates the use of a force gage on a special stand.

The last category I will discuss is tearing testers. The leader in this field, of course, is the well known Elmendorf tearing tester. Perhaps some of you are not acquainted with the various modifications which are presently available with the Elmendorf tester. One of these is the torsion tear attachment. This device is ideal for cylinder board and reinforced gum shipping tape where the tendency of strongly directional materials to tear askew on the standard tester have caused difficulty.

Another attachment for the Elmendorf tester is the toughness tester, by means of which the material placed in the grips can be given a sudden dynamic jerk. This is very similar to the type of force which is exerted on the Van der Korput static dynamic tensile tester.

In addition to the Elmendorf tearing tester there is a Bekk edge tearing test developed by Dr. Bekk in Holland. This is suitable for relatively strong materials. There is also, of course, an initial tear test available which does not require the initial slitting of the sample as is done on the Elmendorf tester.

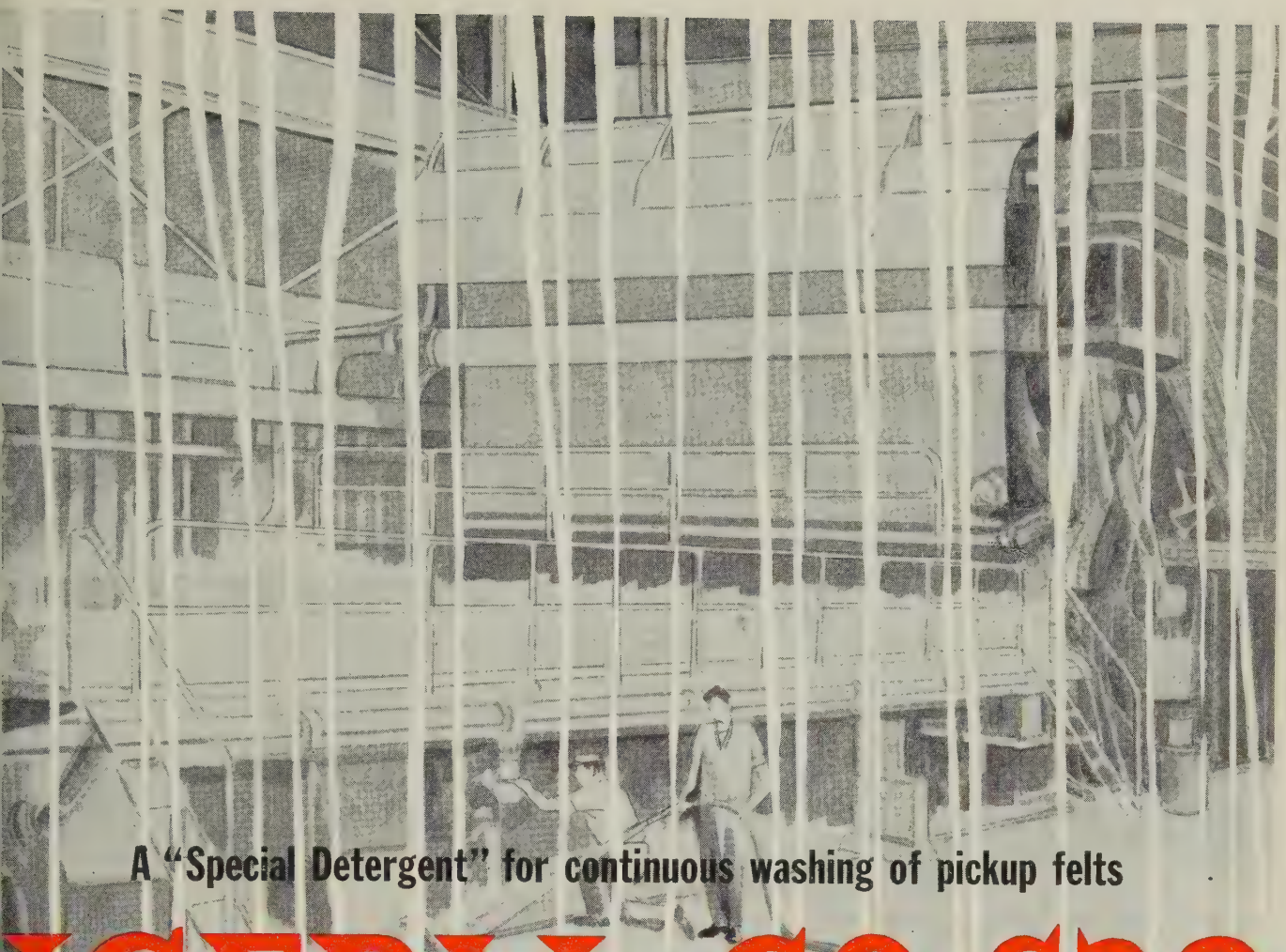
There are many categories of tests and testers which I have deliberately overlooked. One of these is tensile testing. It is a subject which would require more time than we have to cover it in any detail. There are many other testers which we will not have time to cover. Some are brightness, color, and the many, many tests for component materials which I have not mentioned.

I would like to add, however, that the testing machine alone will not give you satisfaction unless you take into consideration all other factors involved. We have developed what we call the TMI formula. When people come to us for help regarding a testing problem, we take into consideration the tester, which they may have or which they intend to purchase, the method which they intend to use, and thirdly, the intent of their test or testing program. It is our firm conviction that all of these factors, tester-method-intent, must be considered equally. To have an expensive, complicated instrument is very well, but to use it, where a less costly or faster tester will suffice is expensive, and wasteful. The method should always be defined in all respects. At the same time, we feel that the purpose of a test, or the intent of a test, should always be considered. Will the instrument be used for research or quality control or even for sales promotion purposes?

In our discussion today, we have mentioned instruments which are largely used for quality control. In some cases these instruments were developed to accomplish a specific purpose. They should not be called upon to perform research functions for which they were not designed.

We feel that every testing problem should be given this three sided evaluation—using the formula. The instrument makers are ready to supply what the industry wants but it seems prudent for all concerned that we not lose sight of this interrelationship between the tester, the method, and the intent of the test.

Presented at the 44th Annual Meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 23–26, 1959.



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is economical, easy to apply... lengthens felt life

Because of its truly nonionic nature, Igepal CO-630 does not form insoluble precipitates with calcium and magnesium, as does soap, or anionic based detergents. This nonionic detergent is compatible with alkaline salts, acids and commonly used solvents, but contains no harmful alkalis to weaken felt.

Paper machine wet-end felts can be washed with Igepal CO-630 solutions in the usual felt conditioning units, either continuously or intermittently while running; there is a minimum of foaming action. Igepal improves drainage, is positively non-shrinking. Complete technical information supplied on request. Simply write—

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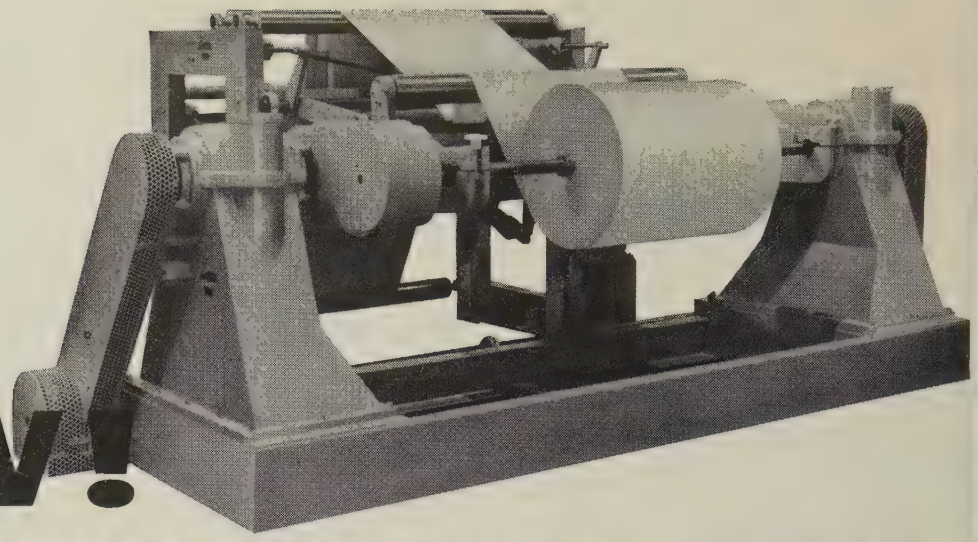
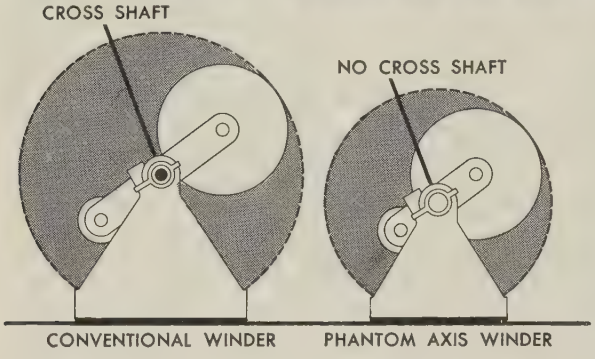
Igepal CO-630, manufactured by General Aniline & Film Corp., is sold outside the United States and Canada under the tradename Antarox CO-630 by distributors all over the world.



NEW!

EGAN PHANTOM AXIS TURRET WINDER



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Write, or phone Randolph 2-0200, for illustrated technical data giving complete information on the new Phantom Axis Winder Series, and its companion unit, The Egan Phantom Axis Turret Unwinder.

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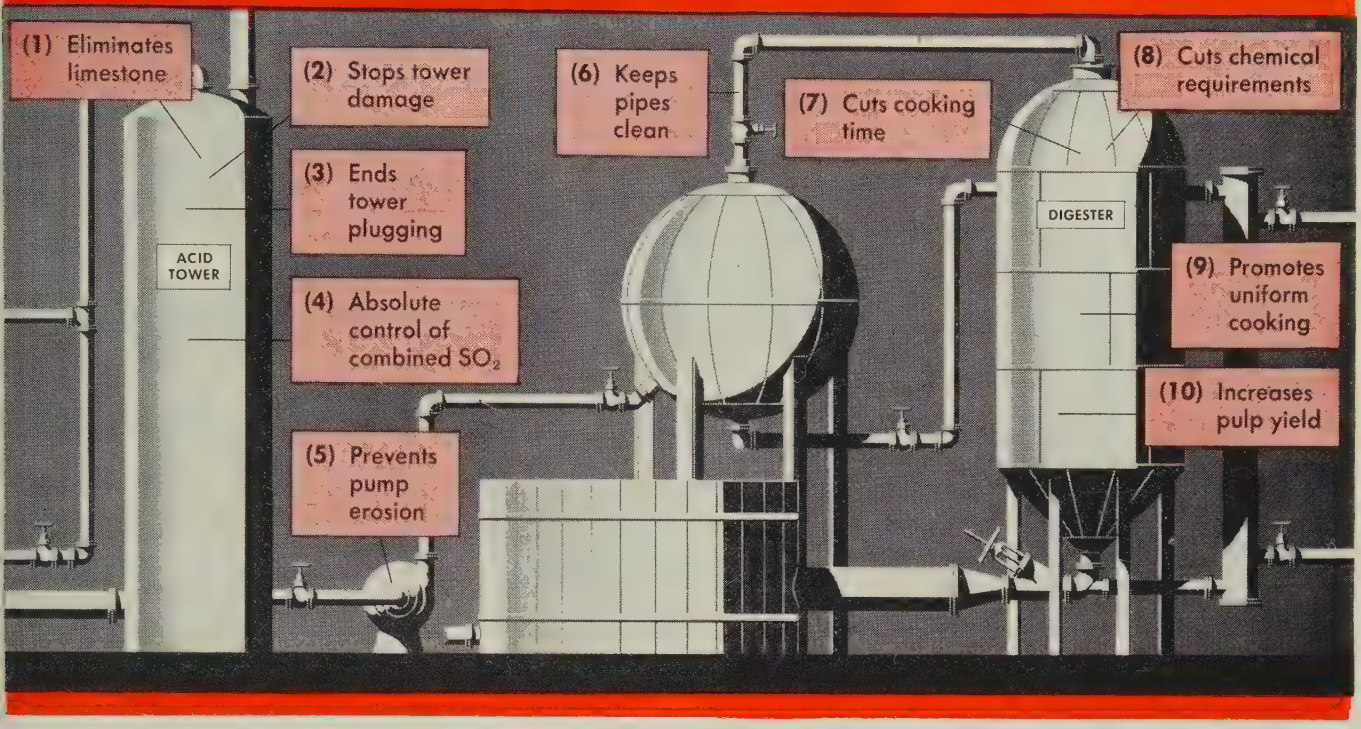
10 Ways Ammonium Bisulphite Pulping Can Help Increase Your Pulp Mill Profits:



Here's how Spencer Anhydrous Ammonia saves time, cuts costs and increases yields. Read how this quicker, cleaner, better method of pulping can benefit your mill:

It is generally agreed that ammonium bisulphite pulping offers many advantages. Ten of these advantages are shown above. Now, let's look at what some of these advantages can mean to you:

In the first place, Spencer Anhydrous Ammonia ends the need for stone handling. This reduces labor costs and, at the same time, stops damage formerly caused by dumping stone into the acid tower.

Pipes are cleaned, not clogged, by ammonium bisulphite acid. With ammonia base, absolute control of combined SO_2 is accomplished by the mere twist of a valve.

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Why not set up a test run, and prove in your own plant the benefits of this pulping process? Our Technical Service Staff will be glad to provide you with technical assistance. Just write: Technical Service Section, Spencer Chemical Company, Dwight Building, Kansas City 5, Missouri.

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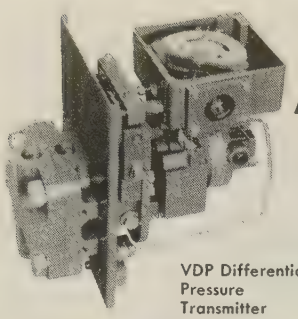
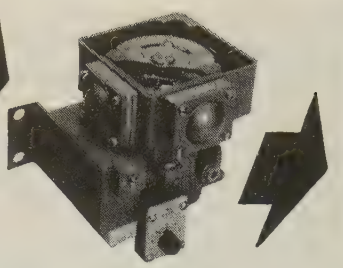
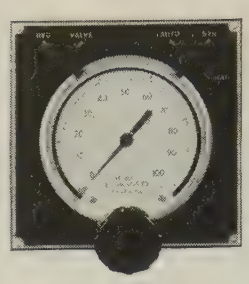


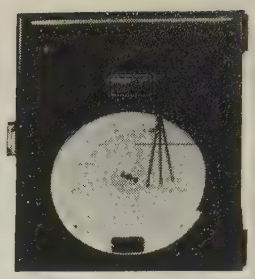
VDP Differential Pressure Transmitter



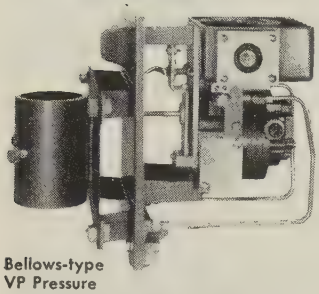
VC Controller



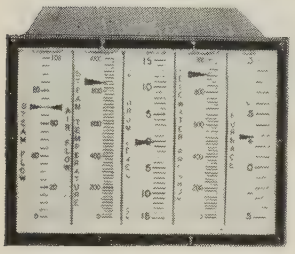
Type "A" Control Station



Flow, Pressure and Temperature Recorder



Bellows-type VP Pressure Transmitter



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Versatile Republic final drive units operate dampers, valves, inlet vanes and many other mechanisms. May be locally or remote controlled, by manual or automatic means. Proportionality of signal response can be tailored by a cam shaped on the job.

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REPUBLIC INSTRUMENTS AND CONTROLS

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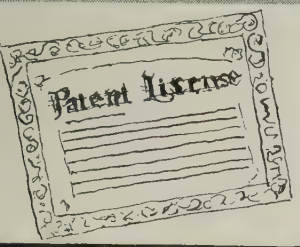

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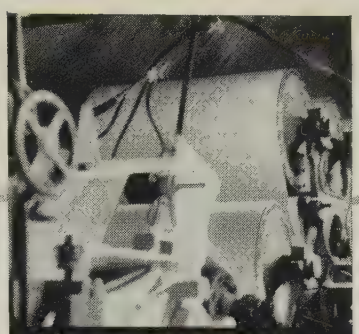
Well, perhaps there's a little more to your gaining use of Becco patents than just mailing your dollar in, but not much more. And certainly, no more money. The $1.00 really does cover it.

Becco has lots of patents, granted as a result of innovations in the use of Hydrogen Peroxide and other Peroxygen chemicals developed in Becco's Research Laboratories. But they don't do us a whole lot of good locked tightly in our safe. So, we long ago adopted the following policy:

If one of our patents can help you, we'll be glad to license the rights to you **perpetually,** for just one dollar. You get a nice certificate, incidentally, to cover the legalities, but more important — you also get free our complete engineering help in setting up your process, handling the material, maintenance, etc., etc.

What do **we** get? You as a **customer** — we hope — but there's no obligation on your part. Just seems to work out that way, though — when we know enough about a particular peroxygen to hold a patent on its use, chances are we've also learned enough to produce it purer than anyone else. You benefit from this; we do, too.

Use the coupon below to ask for a Sales Engineer — or our list of patents — that may help you solve an important problem.



How BRIGHT Is BRIGHT?

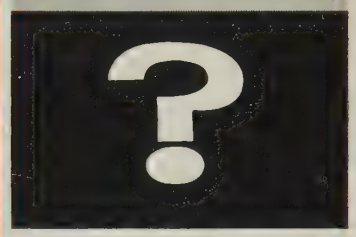
That's a hard question to answer. It depends on how the pulp is treated.

Trouble is, paper can show an 86 level at the layboy, but by the time the paper is delivered, this has dropped to 82 or lower. With conventional bleaching methods, that is.

Many chemical pulp producers have found the answer to this problem in Becco's Dryer Steep Bleaching Process (patented, but licensed perpetually for one buck). Applied by means of spray pipes across the pulp sheet ahead of the dryers, Becco Hydrogen Peroxide increases brightness permanence and bleaches in transit. Often, in fact, an 86 layboy level **improves** to 88 by delivery time.

This is just one example. Becco has a vast amount of technical knowledge compiled from 31 years of experience with **all** types of pulp. If **you'd** like help with your pulp, free of any obligation, let us know with the coupon below.

Problems in handling Hydrogen Peroxide



Becco's Four-Fold Engineering Service Program — offered free — includes:

1. Comprehensive survey of your facilities.
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3. Installation supervision by Becco.
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Can you use this free Becco help, based on more years of experience with bulk handling of H_2O_2 than any other manufacturer? Use the coupon to let us know.

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Dept. T-F

Gentlemen:

Please send your list of patents available on the use of

- ☐ Hydrogen Peroxide
- ☐ Peroxygen Chemicals
- ☐ Persulfate Chemicals
- ☐ Please have a Sales Engineer call.

NAME_____

FIRM_____

ADDRESS_____

CITY_____

ZONE____ STATE_____

BECCO fmc

BECCO CHEMICAL DIVISION, FMC
Station B, Buffalo, New York

Dept. T-C

Gentlemen:

We **would** like help with our pulp. Please have a Becco Sales Engineer call.

NAME_____

FIRM_____

ADDRESS_____

CITY_____

ZONE____ STATE_____

BECCO fmc

BECCO CHEMICAL DIVISION, FMC
Station B, Buffalo, New York

Dept. T-B

Gentlemen:

Please tell me more about your Four-Fold Engineering Service.

NAME_____

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Four features that spell recovery unit performance

1. Panel Type Superheater and Screen
2. Tangential Overfire Air
3. Decanting Hearth
4. Precise Control

These are design features of the C-E Chemical Recovery Unit. How they contribute to efficiency, economy and flexibility is discussed below. That they blend into an integrated design is evident from the acceptance the unit has received, as indicated by the list at right. Note that the smallest unit listed has a capacity of 1,500,000 lbs. of dry solids—a size unheard of just a few years ago. Note, too, that three of the eleven contracts are repeat orders.

C-E Contracts for Large Recovery Units
(500 Tons and above)

Name	#Dry Solids/24 Hrs.
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Union Bag & Paper Corp.	1,610,000*
Halifax Paper Co., Inc.	1,500,000*
B. C. Forest Products Ltd.	1,600,000*
Longview Fibre Co.	2,000,000*
Crossett Paper Mills	1,500,000*
International Paper Co.	1,500,000*
Enso Gutzeit OY	1,500,000
Union Bag & Paper Co.	1,610,000
East Texas Pulp & Paper Co.	1,600,000
Enso Gutzeit OY	1,500,000

*In service

1. PANEL CONSTRUCTION

The widely spaced self-cleaning panel type superheater and screen—developed by C-E—provides no foothold for slag. Gas passage is smooth and unimpeded. Slag build up is minimized, gas flow and heat absorption is uniform across the width of the furnace, surfaces are cleaner and soot blower action is more effective.

2. TANGENTIAL AIR

Secondary air is introduced tangentially above black liquor sprays. Fuel-air mixture is intimate and complete. Gas velocity upward through the sprays is decreased, ash entrainment in gases leaving furnace is reduced. Combustion is completed in lower part of furnace, furnace exit gas temperature is reduced.

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A layer of chilled smelt is held in contact with the water cooled furnace floor. Molten smelt rides on top of the chilled layer and leaves the furnace without touching hearth refractory or floor tubes. The cost and inconvenience of downtime due to hearth failure is eliminated.

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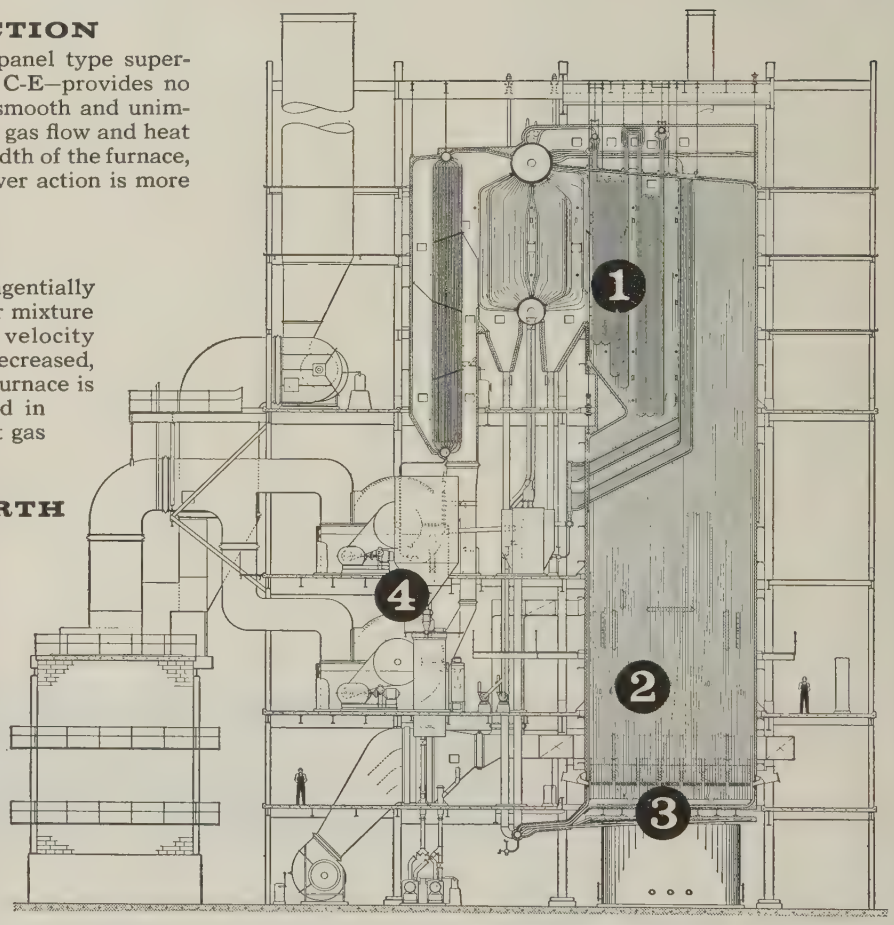
Furnace stability is assured because evaporative heat is controllable to compensate for density differences in incoming liquor, regardless of limited multiple effect evaporator capacity. Liquor temperature is controlled accurately and automatically and fuel-air ratios are automatically proportioned to maintain the furnace atmosphere required for high reduction.



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"Improved Felt Performance" is intended for use as a technical aid to mill managers, superintendents and machine personnel, and should prove helpful as a training program textbook. It supplements our original "Suggestions For Improved Felt Performance" (1955) as the industry's standard guide to profitable paper machine felt operation.

Ask your Albany Felt Sales Engineer for your free copy or write directly to us. You will be glad to have this useful technical manual.

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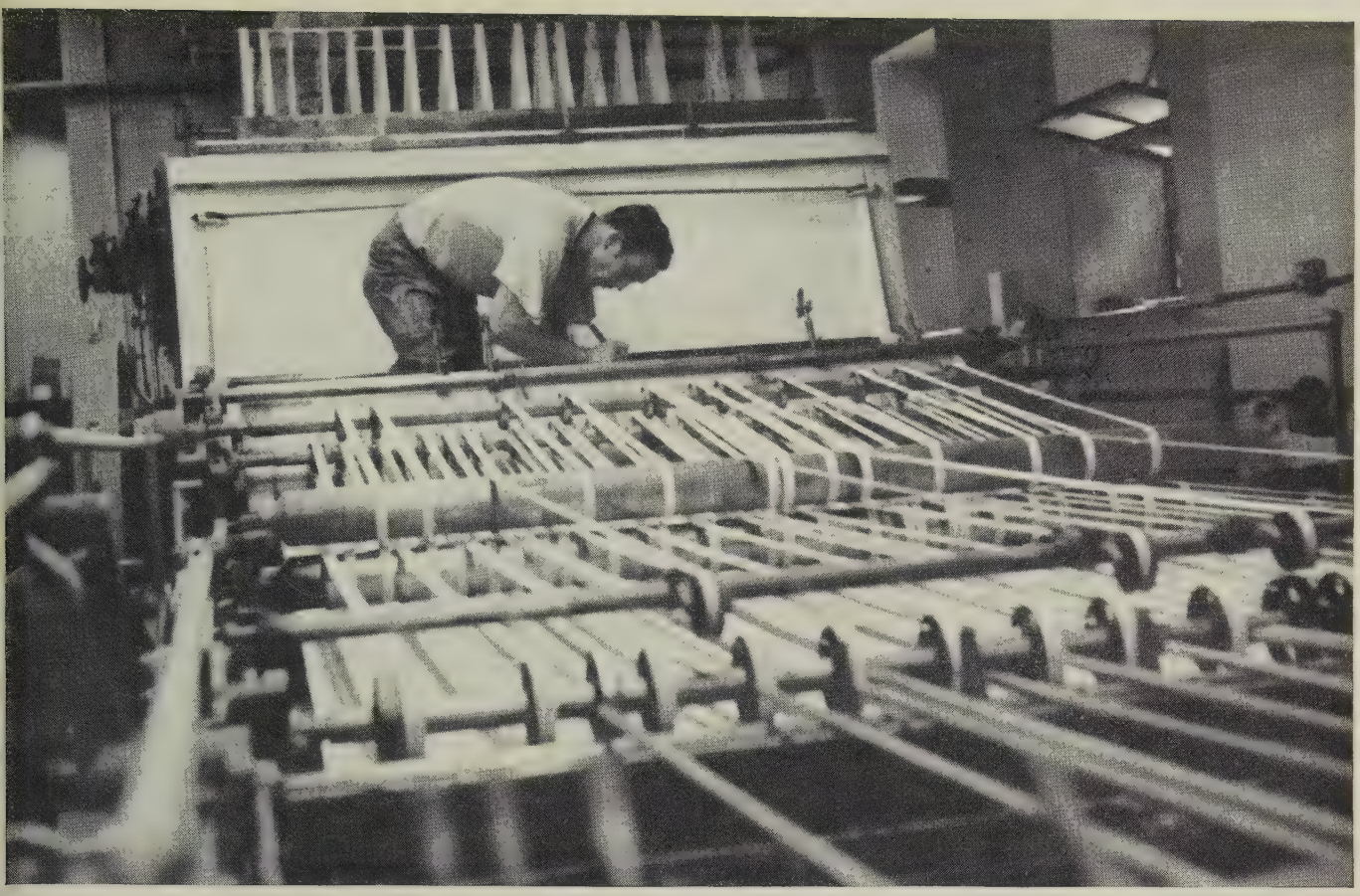


Burd & Fletcher Co., Kansas City, Mo., report

"Cities Service Pacemaker 42 Wax gives best results, bar none"...

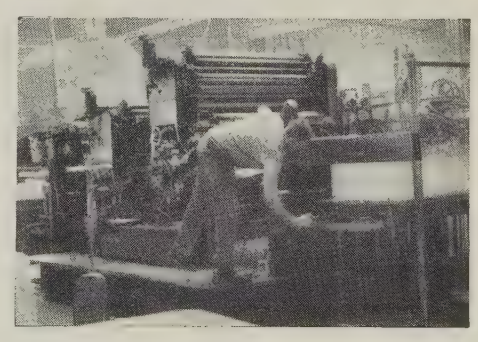
Burd & Fletcher Company originally started in 1886 as a printing company and then progressed to boxmaking. By 1936 they were producing as many as 2,000,000 boxes a day. Now, Burd & Fletcher is one of the largest paper box manufacturers in the Midwest area, using several hundred tons of paperboard each month.

Burd & Fletcher know that the box they produce can be no better than the wax they use and the coating the box receives. **And after extensive testing, they selected Cities Service Pacemaker 42 for coating their special food boards.**

The production department likes Pacemaker 42 for its cleanliness . . . keeps machines running cleaner. Burd & Fletcher also found that Pacemaker 42 produces a smooth gloss . . . better than others tested. Further testing showed Pacemaker 42 gives a full coating, prevents leakers and does not block. **Mr. R. T. Guernsey, Vice President of Burd & Fletcher, especially recommended Cities Service Technical Service Department for their fast, efficient help.**

Contact your nearby Cities Service office for a Wax Representative to give specific recommendations for your operation . . . or for further information, write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

Special Cities Service CarTons facilitate easy handling and efficient storage of wax. Local warehousing cuts delivery time and reduces necessary inventories.



Seventy Years Ago Burd & Fletcher used a far smaller press compared to this high-speed giant. When the firm started in 1886, their prime business was printing catalogues.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

Some Aspects of Sampling for Specifications

GEORGE G. MALTENFORT

THERE has been a growing realization in TAPPI as well as ASTM that the advent of probability sampling has rendered the old sampling instructions contained in most test procedures out of date. These generally say something about getting "representative" samples and designate some arbitrary number such as 5, or 10, or whatever, as the minimum number of samples to be tested. Even in those cases where specifications, customer or government, do embody modern concepts of probability sampling, certain problems tend to cause difficulties to manufacturer and consumer alike.

A general method for sampling of paper and paper products has recently been described in the literature (*1*). In this paper we would like to confine ourselves to the specific aspects of sampling for specifications, i.e., acceptance or rejection of product and referee sampling, those areas intended to be covered by TAPPI and ASTM procedures, and to quality controls, and not to sampling for design of experiments, which is another subject.

PRODUCTION PROBLEMS

One recurring sampling problem is how to reconcile the "random" requirement (every sample shall have the same probability of being chosen for testing as every other) with practical limitations when the item is a roll of paper, say liner or medium. Suppose we purchase a carload of 10 rolls of corrugating medium and we specify that its Concora medium test shall be some given average value. The mill certainly cannot periodically throughout the web cut out paper to test for CMT. No box shop would accept rolls with cuts or holes in them. Similarly, the box shop cannot unwind the roll to take samples throughout, they do not want to cut holes in the web either, and even if they could, they could not rewind the roll. The solutions are obviously a compromise. The mill can sample each roll from front to back once at the beginning and once at the end of each roll, and get from 3 to 6-sq. ft. samples each time. Since they have no way of knowing (and therefore controlling) the location of the samples beforehand, this is certainly a random sample. The samplings will thus yield from 30 to 60 front to back results and this is therefore a practical way of getting a meaningful estimate of the carload lot average CMT. Such a sampling procedure has proved well suited to quality control and acceptance sampling purposes.

Another puzzler is how to sample a product which has both attributes *and* variables characteristics. For example, a corrugated box consists of liners and medium which have basis weight, caliper, burst, etc., and the combined board in turn has weight, caliper, flat crush, burst, etc., and the box has dimensions, compression strength and so on, all of which are variables type characteristics, i.e., they can be measured on a continuous scale. But in addition to these, the box is printed and therefore it may or may not be smeared, there may or may not be offset, register can be in or out, code letters can be present or absent, and so on. These are attributes and the box either has them or not. In PPP-B-636 this problem is solved by listing the attributes under "Examination of End Item" (par. 4.3.2.1) and applying the usual standards of attribute sampling to them in accordance with Mil. Standard 105-A. The variables characteristics are specified separately, in this case requiring conformance to Uniform Freight Classification Rule 41. This is a very satisfactory arrangement for the purpose.

On the other hand, if in the process of manufacturing we would like to keep track of both attributes and variables characteristics, then we are faced with keeping charts on the attributes, and separate charts for the measured characteristics. The time and cost of doing this is prohibitive.

To answer this problem we have recently experimented with a modified "fraction defective" chart. Instead of fraction defective, P, we use fraction OK of nondefective, Q, so that the formula for calculating the limits would be:

$$\bar{Q} \pm 3 \sqrt{\frac{\bar{Q}\ 100 - \bar{Q})}{n}}$$

This is only a psychological change, of course. The next step is to set minimum limits on each of the variables characteristics, classifying each measurement into "conforming" and "not conforming." That converts it into an attribute and permits the use of one chart only. For example, suppose that on the corrugator we wish to control: (1) caliper, (2) dimensions (of the blank), (3) flat crush, (4) pressure roll cutting (low burst), (5) adhesion, (6) unbonded flutes, (7) leaning flutes, (8) warp, (9) scoring, (10) slitting, and (11) finger lines.

We can list the actual burst, flat crush, and caliper so as not to loose the actual test values, but we can convert each of the items 1–4 above, which are measured values, into two classes and list them as good (if above the minimum tolerance) or bad (if below), and combine these with the other attributes into a single "fraction nondefective" chart. First indications are that this works out satisfactorily, provided no attempt is made to weigh each attribute according to it importance or severity. This creates no end of controversy and is to be avoided. Such a method conforms completely to standard control chart practice and yet offers a way out of an otherwise insoluble dilemma.

STATISTICAL PROBLEMS AFFECTING SPECIFICATIONS

Suppose we are dealing with a set of compression

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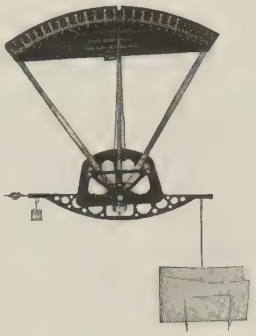

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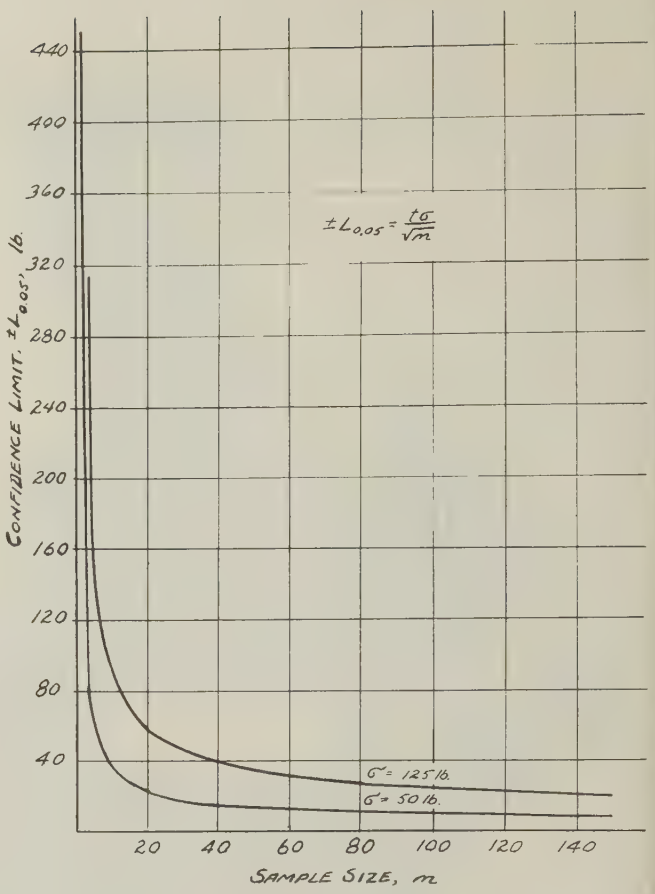

Fig. 1. The reproducibility of compression test means versus sample size

specifications on double wall corrugated boxes. We have recently published extensive data (*2*) showing that there is a definite correlation between σ, the scatter of data, and the average test level, i.e., the compression strength of boxes testing 4000 lb. varies over a wider range that that of boxes testing 1000 lb. (Fig. 1). This is a very general characteristic and not at all confined to compression tests of boxes. In terms of specifications this means that even if we ignore all other causes of variation and consider only this particular effect, then the test variability expressed as a percentage of the mean can fluctauate from 4.8 to 11.7%. Obviously a specification of the (very common) kind: "A box should test an average of so many pounds, ±5%" will cause trouble for anyone trying to comply.

What about a specification which fixes the number of tests to be made as well as the number of pounds within which the average must agree with the specified value? Such a specification conflicts with the inherent mathematical relationship between reproducibility, variability, and sample size. If the sample size is to be fixed regardless of the test level, then the reproducibility will vary with that test level. If the reproducibility of the average is to be a fixed value, then the sample sized to achieve it must be allowed to vary.

To illustrate: Suppose that on one style of a double wall box the value of σ, the scatter of the data, is 50 lb. and on another style it is 125 lb. Let the reproducibility of the compression test average be $\pm L0.05$, the confidence limit within which we can expect the mean value to fluctuate 95 times out of 100. Let n be the number of samples on which the average is based, and let t stand for "Student's t" with $n - 1$ degrees of freedom, found tabled in any standard text on statistics. Then the relationship between them can be shown to be:

$$\pm L0.05 = \frac{t\sigma}{\sqrt{n}}$$

Calculating these values out we have:

$\pm L0.05$ for σ = 50 and 125 lb.

Sample size	σ = 50 lb.	σ = 125 lb.
2	451	1127
3	124	311
4	80	198
5	62	155
6	52	131
7	46	116
8	42	105
9	38	96
10	36	89
11	34	84
12	32	79
15	28	69
20	23	58
25	21	52
50	14	36
100	10	25
150	8	20

This brings out the following very important points:

1. A specified value of $\pm L0.05$, the reproducibility of the mean, can be achieved with fewer samples if σ is small, and with more samples if σ is large. In our

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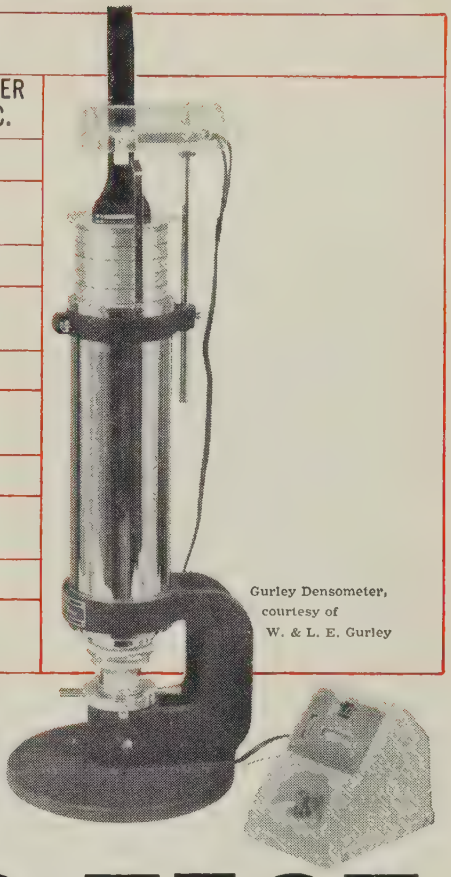
		CONTROL PLUS 0.2% KELSIZE S	28
C	34 x 22—14 LBS.	CONTROL (USUAL FORMULA)	17
		CONTROL PLUS 1.0% KELGIN XL	59
D	17 x 22—25 LBS.	CONTROL (USUAL FORMULA)	26
		CONTROL PLUS 0.3% KELGIN LV	40
E	34 x 22—32 LBS.	CONTROL (USUAL FORMULA)	400
		CONTROL PLUS 1.5% KELGIN XL	1800



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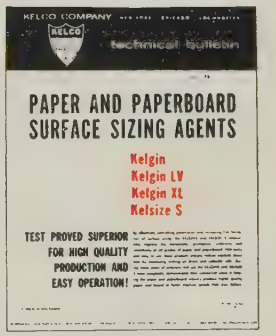

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example if the average is to be within ±52 lb. it requires six tests in one case but 25 ests in the other.

2. Beyond a certain range, going to greatly increased sample sizes increases the reproducibility of the mean value (lowers the value of $\pm L0.05$) but little. Therefore small increases in reproducibility must be paid for with prohibitive increases in the number of tests.

3. Since the curve for $\pm L0.05$ flattens out rapidly, and a certain amount of scatter is inherent in the data, it is obvious that no practical finite number of tests can lower the value of $\pm L0.05$ below a certain level, no matter how many tests are run to obtain the average.

4. Finally, since σ is given by the nature of the distribution itself, one can either fix $\pm L0.05$ arbitrarily (within the limits obtainable) and let n fluctuate to attain this reproducibility, or else we can fix the sample size, and then $\pm L0.05$ will vary with σ. To fix both is impossible, if compliance to the specification is expected.

We conclude with a few comments on the relationship of probability sampling to the TAPPI and ASTM test procedures, particularly those portions specifying the precision of the test results and the number of tests to be run. Due to time and space limitations we cannot enter into a discussion of the general principle of sampling. the fallacy of constant percentage sampling, etc. We must limit ourselves to giving you a few basic references (*3–6*) which deal very lucidly with the subject. Suffice it to say here that in the field of acceptance sampling, one of the important areas of application of standard test procedures, four additional factors must be recognized, in addition to those we have discussed in our example above. The use of probability sampling entails two kinds of risk, one is known as the producer's risk (generally called α) and the other is the consumer's risk (generally called β). The producer's risk is the chance he takes that an acceptable lot will be rejected, while the consumer's risk is the chance that he will accept a lot which he should reject. The choice of these two risks can never be arbitrarily fixed, it depends entirely on the nature and end use of the product to be tested and the degree of risk consumer and producer are willing to take or can agree on. Moreover, different products require considerably different values for the desirably low value of fraction defective (also known as the AQL or acceptable quality level) as well as for the undesirably high value of fraction defective (also known as the LTPD, the lot tolerance percent defective) respectively designated as p, and p_2. The sample size is determined by the choice of p_1, p_2, α, and β, and different choices give rise to different sampling plans, having different operating characteristics. In the paper and paper products field, our ASTM and TAPPI standards take no account of this. We believe that it is impossible to reconcile these concepts within the framework of each separate test procedure, and have accordingly suggested the elmination of sampling instructions in each individual standard. Instead we proposed referring in each case to a general standard dealing specifically with sampling (*1*).

In summary we have sought to clarify some important issues relating specification problems to some basic issues which arise in sampling, both for acceptance and for quality control purposes. A proper understanding of these issues will greatly simplify the problem of conforming to specifications, reduce controversy, and often save needless expenditures of time and money.

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Presented at the 44th Annual Meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 23–26, 1959

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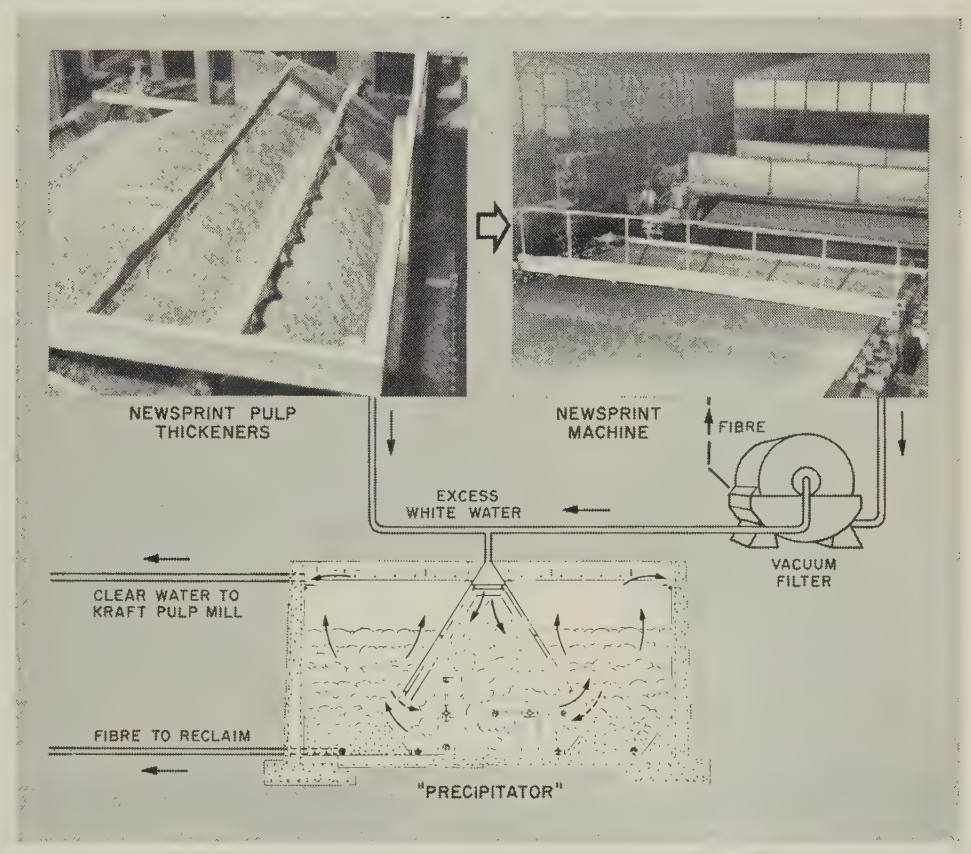

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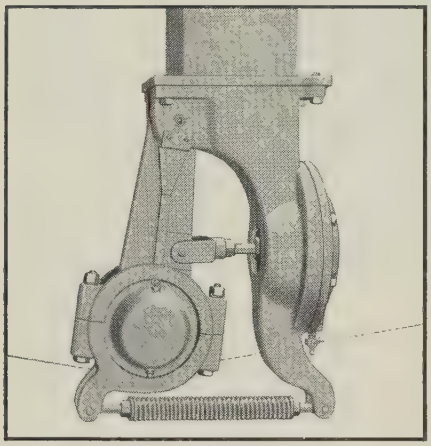

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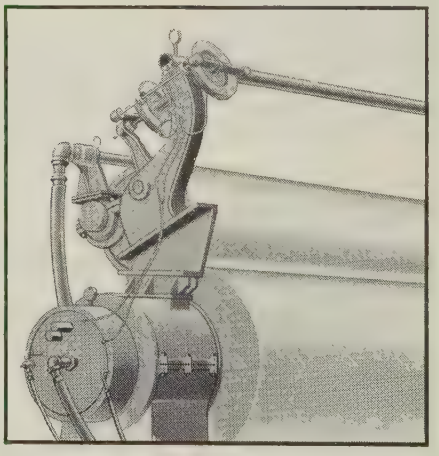

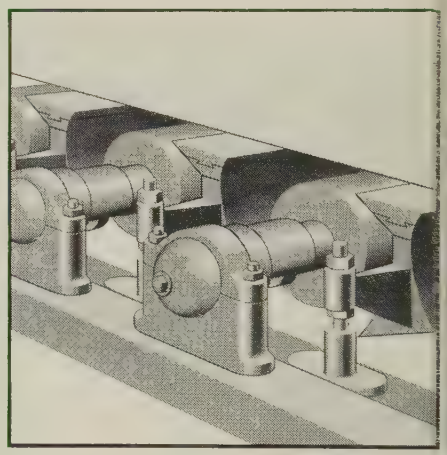

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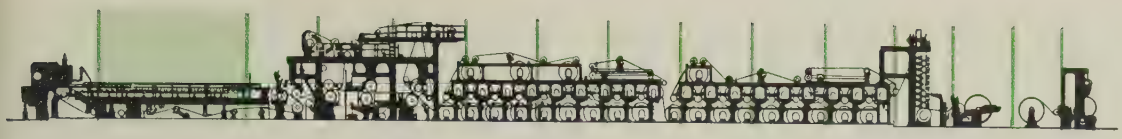

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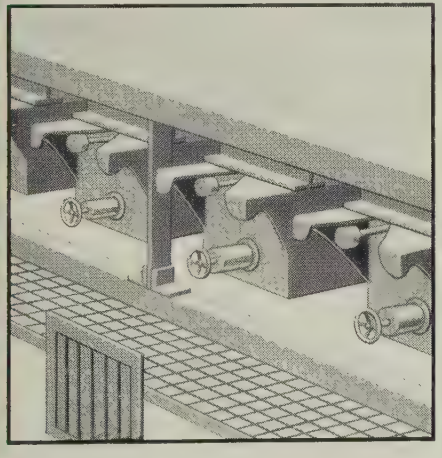

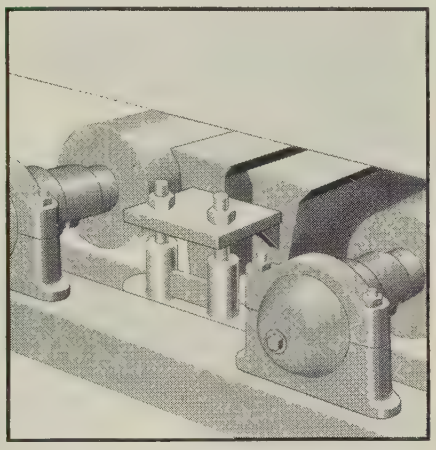

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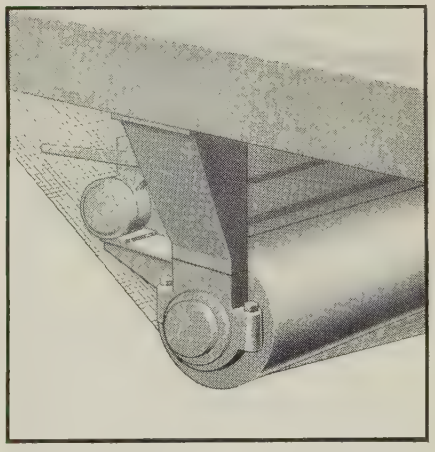

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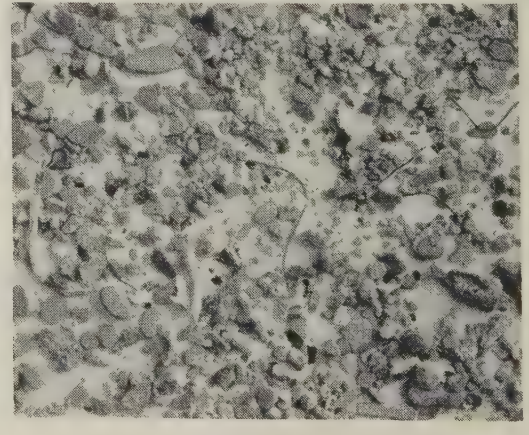

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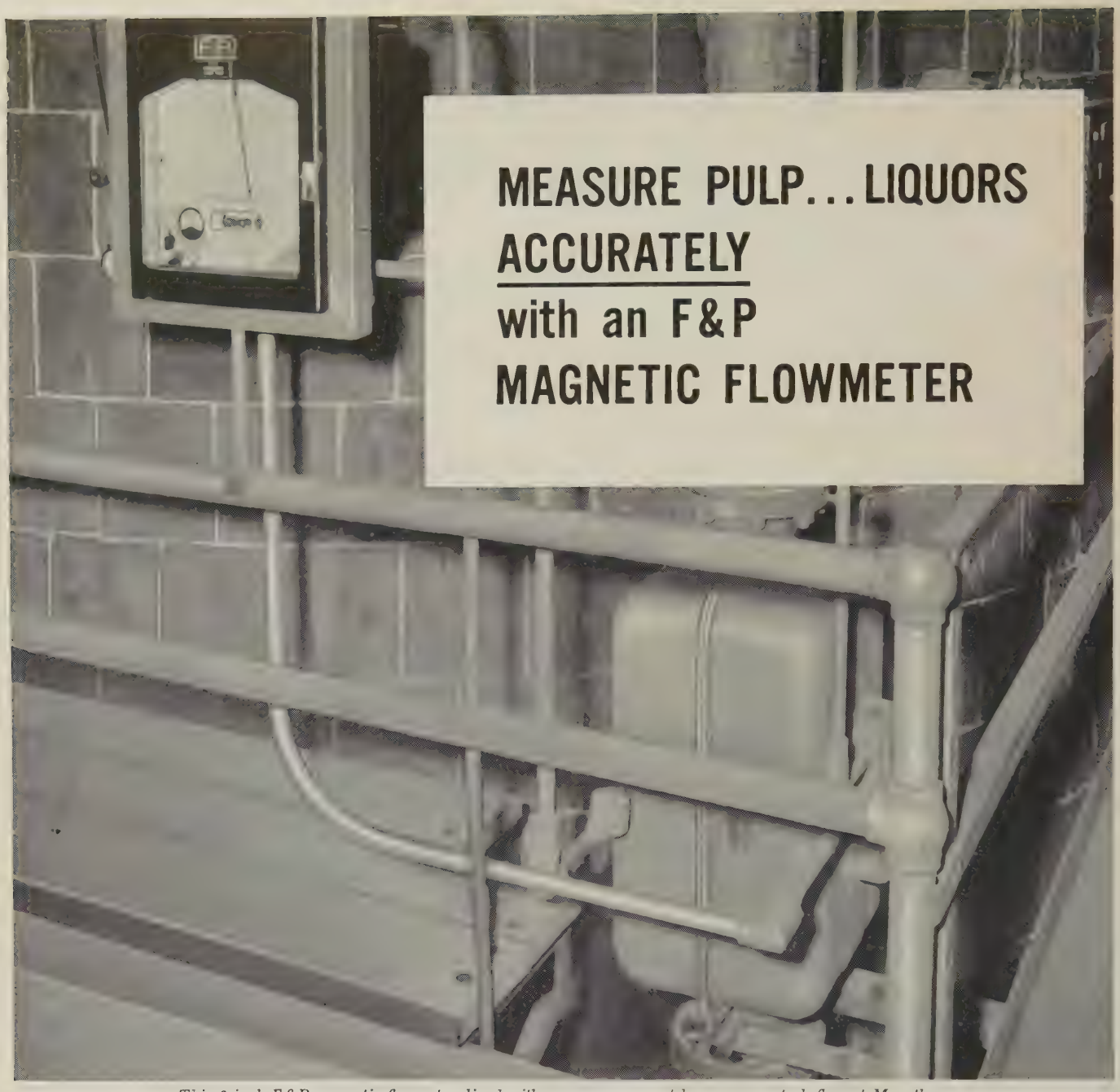

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But that's not all. Since flow through the magnetic flowmeter is essentially flow through a straight length of pipe, there's no restriction on materials of construction. Caustic... chlorine... hypochlorites... even black liquor . . . there's an F&P magnetic flowmeter fitted for the toughest corrosion service in the mill.

Sizes are available to suit every flowmetering requirement, from ½" on up. Volume rate of flow is measured *accurately* . . . in either direction . . . independent of viscosity, density, or turbulence. You can forget about straight runs of pipe, valve placement problems, and straightening vanes.

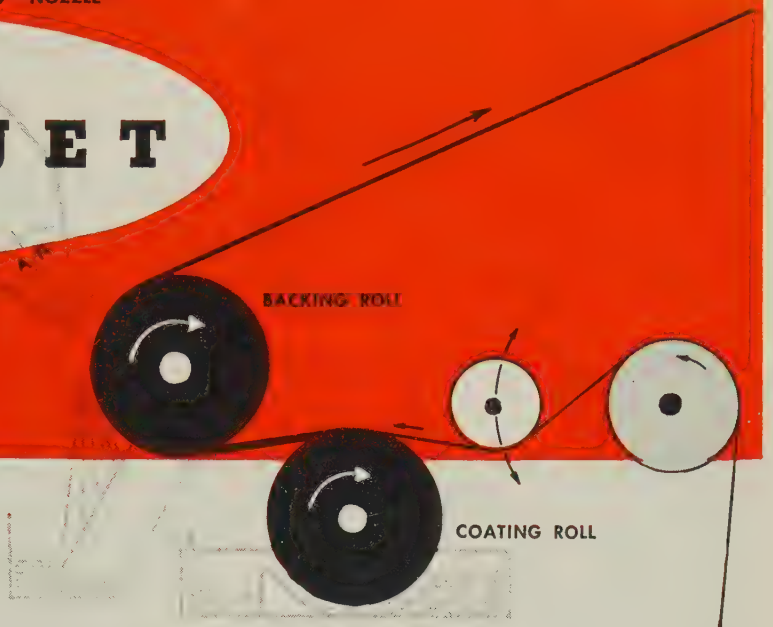
Convenience, too! Any F&P magnetic flowmeter can be used with any of the complete range of F&P secondary instruments available. No custom matching. And any flow velocity from 1 to 30 fps can be set at full scale with a flick of a dial. Plenty of flexibility . . . plenty of room for future process expansion.

Get the facts on the F&P magnetic flowmeter Now! Contact the F&P field engineer nearest you, or write for Catalog 10D1416. Fischer & Porter Company, 1749 County Line Road, Hatboro, Pa. In Canada, Fischer & Porter (Canada) Ltd., 2700 Jane Street, Toronto, Ontario.

FP FISCHER & PORTER COMPANY *COMPLETE PROCESS INSTRUMENTATION*

MICROJET

the **COATER** *where the metering is done by high velocity air*

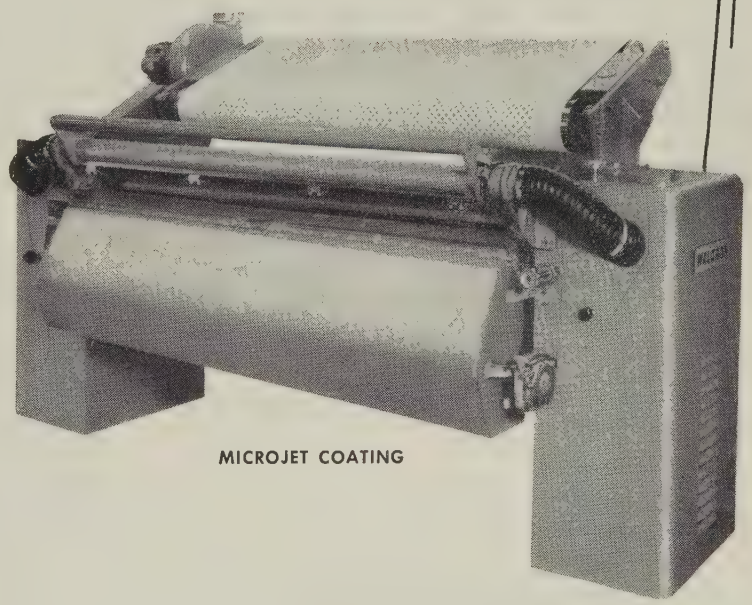


. . . and a clean, smooth, uniform job of metering it does, too! The accuracy is exceptionally high!

The quality of coat coming from the MICROJET Coater is exceptionally fine, being completely free of scratches or other surface imperfections. The economy is high in that maximum coverage per pound of coating is obtained.

The WALDRON MICROJET Coater can be installed actually on or immediately in series with the paper or board machine, if so desired. The finished sheet would require no further converting.

The MICROJET has been so successful wherever it has been installed—and the many units already in operation range up to 226 inches in width—that we suggest you discuss its advantages with one of our engineers in connection with that coater project you have in mind. It has much to offer.



MICROJET COATING

During their many years of service to the Web Processing Industry, Waldron Engineers have developed with many variations machines for coating, impregnating, embossing, laminating, saturating, printing, together with auxiliary mechanical equipment such as unwinds, rewinds, edge guides, tension controls, trimmers, slitters, sheeters.

Waldron Engineers have such a broad experience in this field of web processing that it might be very helpful to you to discuss any such project that will be coming up.

M-R

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John Waldron Corporation, New Brunswick, N. J.
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SODIUM CHLORATE
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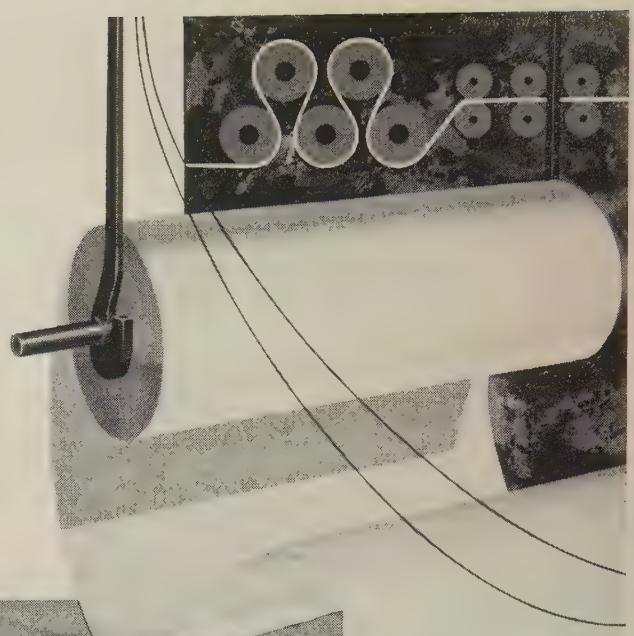

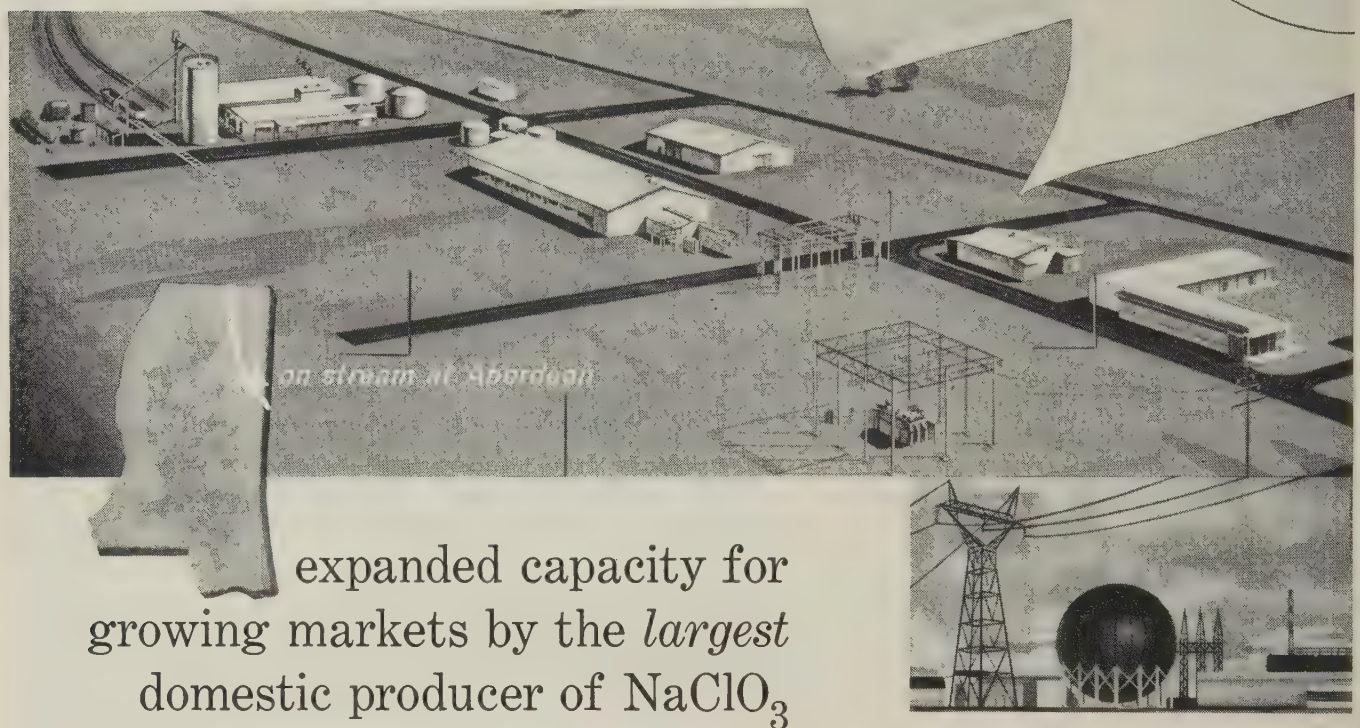

expanded capacity for growing markets by the *largest* domestic producer of $NaClO_3$

The big news in sodium chlorate is TRONA's new electrochemical plant, now on stream at Aberdeen, Mississippi. This latest AP&CC facility provides faster and better service to the South's growing pulp and paper production centers, as well as further assurance of dependable sodium chlorate supply for other important markets in such fields as agriculture, uranium ore processing and solid propellant fuels. Aberdeen's readily expandable, initial capacity of 15,000 tons per year, added to the $NaClO_3$ production capability of Trona's Henderson, Nevada, plant makes American Potash & Chemical Corporation the largest domestic supplier of sodium chlorate...capable of meeting *all demands* from expanding commercial and military users. *Further information on Trona's sodium chlorate service and production capabilities at Aberdeen is available from your nearest AP&CC branch office.*

TRONA

American Potash & Chemical Corporation

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OFFICES: LOS ANGELES, NEW YORK, CHICAGO, SAN FRANCISCO, PORTLAND (ORE.), ATLANTA, COLUMBUS (O.), SHREVEPORT

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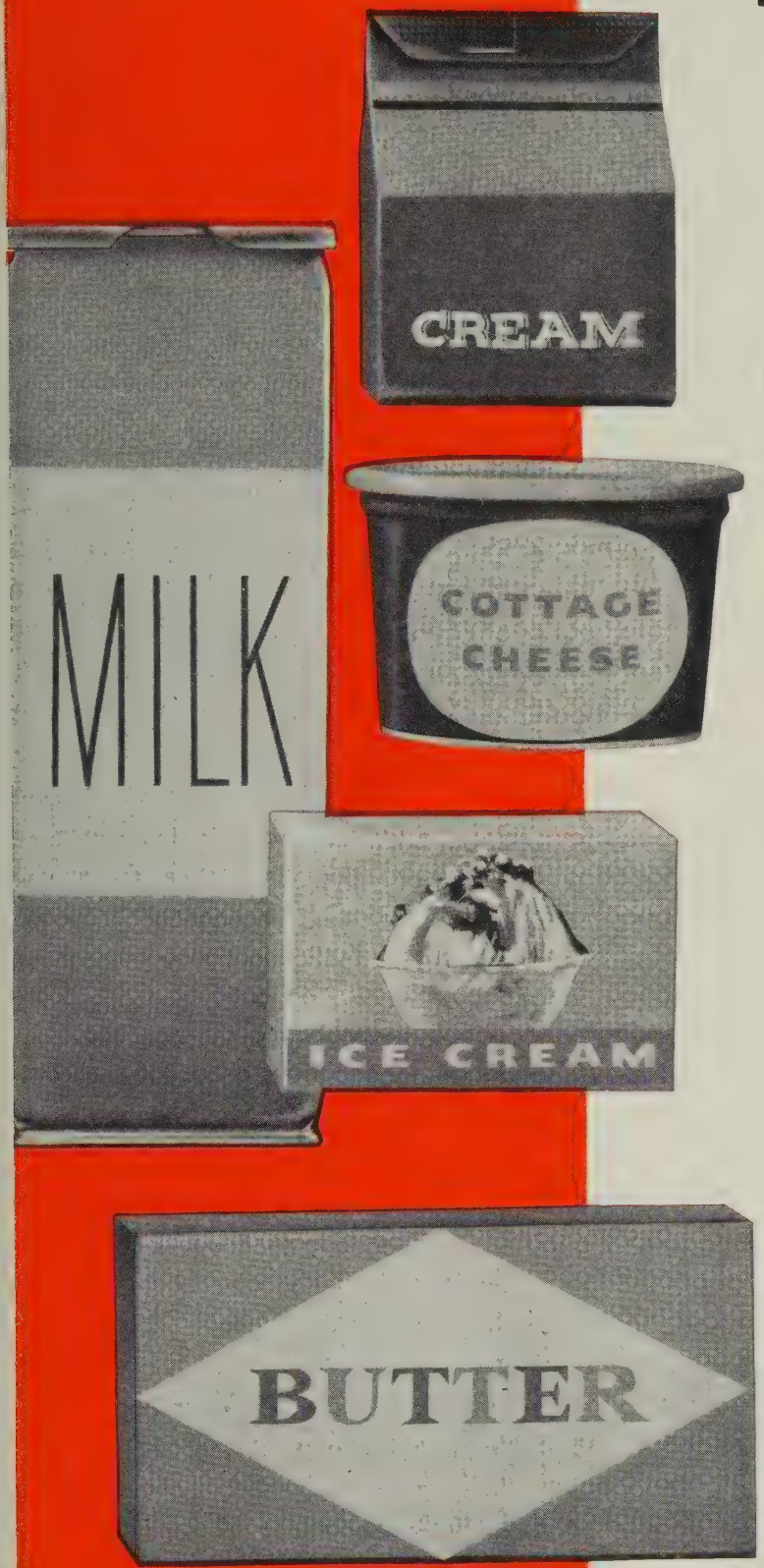
THORIUM • CERIUM • RARE EARTHS • *and other diversified chemicals for Industry and Agriculture*

There's an ATLANTIC wax for every dairy use



Take any assortment of waxed cartons for dairy use: cartons for milk, for butter, for ice cream, for cheese. Chances are that every one of them requires a different type of wax, with different physical characteristics.

That is why Atlantic offers a wax for every dairy use. This variety pays off . . . in improved appearance of your products, and in increased sales for your customers.

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2. STRONG, TURBULENT VORTEX PULLS THE SHREDS INTO THE ROTOR, WHICH BREAKS THEM INTO SMALL FLAKES

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k-receptivity is one of the many reasons printers like s paper. Others are: a smooth, pick-free surface, good rnish holdout, and the freedom from objectionable odors important when paper is used in food packaging.

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RHOPLEX

SHOWCASE FOR QUALITY

Producing pulp of uniform brightness, strength and purity is not left to chance at Weyerhaeuser's new Grays Harbor Mill.

Controls are maintained at every processing stage which automatically measure and record temperatures, pressures, chemical proportioning and other vital functions.

And, even as these quality checks set high standards today, Weyerhaeuser research at Grays Harbor and its other mills is leading to new and better processes and products for tomorrow.

At the filter plant chemical proportioning and filter cleaning are automatically controlled. Water color, turbidity and other quality factors are checked many times daily.

Each cook in each digester is automatically plotted on charts, dials and flashing lights in the constantly manned digester control room.

'Round the clock tests are run on each pulp batch in the main plant laboratory by chemists whose job is to ensure high-quality pulp.

Moisture content and a series of other quality test checks are made every few minutes on pulp as it comes off the drying machine.

Chart room contains process records on all pulp produced.

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SYNTHETIC REINFORCED WOODBERRY 403

FULL-FACED ASBESTOS DRYER FELT

Outstanding Construction
This full-faced asbestos felt is reinforced with fine synthetic yarn, individually selected for each component to provide perfect balance throughout. The overall construction is a tried and proven pattern specifically designed for optimum drying efficiency.

Outstanding Wearability
The asbestos face of Woodberry 403 protects the felt from the hazards of excessive heat. In addition, its sturdy synthetic reinforcing minimizes the effects of abrasion, and provides superior resistance to chemical degradation.

Outstanding Porosity
The Woodberry 403 combines an open, porous construction with the extremely high wicking capability of asbestos to produce what is probably the fastest drying dryer felt on the market today.

Outstanding Finish
A special finishing treatment, developed by Mount Vernon Mills, provides Woodberry 403 with optimum stability and drying characteristics.

Outstanding Efficiency
The superior construction, wearability, porosity and resistance of Woodberry 403 all contribute to its virtually unsurpassed drying efficiency, and its growing reputation as the finest all-purpose heavy-duty dryer felt yet developed.

Like all Mount Vernon Dryer Felts, Woodberry 403 is available, pre-stretched and pre-shrunk, with or without clipper seams.

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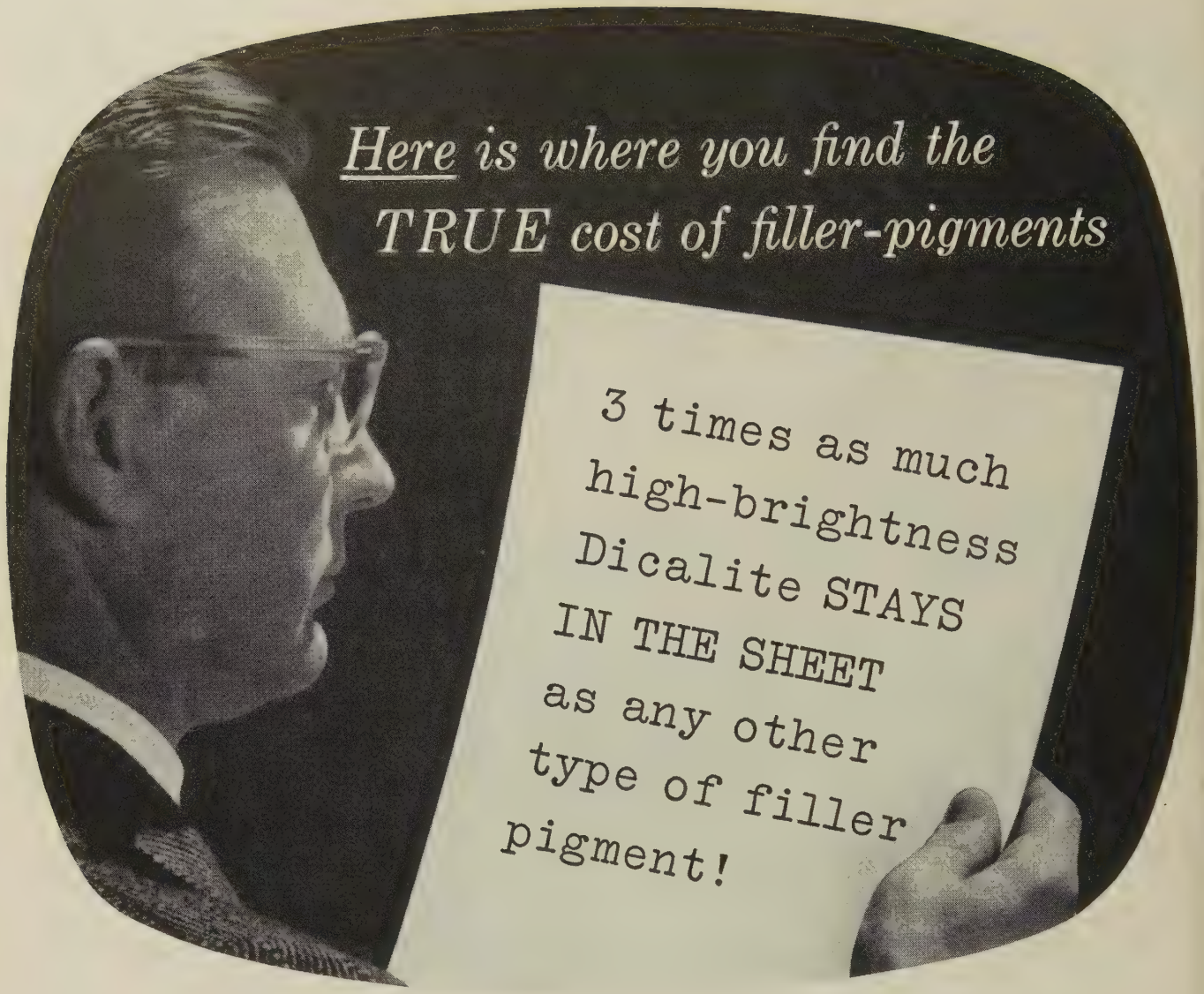
Here is where you find the
TRUE cost of filler-pigments
3 times as much high-brightness Dicalite STAYS IN THE SHEET as any other type of filler pigment!

The true cost of any filler-pigment is cost per pound retained in the sheet—not cost per pound at the beater. And on that basis, high-brightness Dicalite Paperaids are the least expensive filler-pigments you can get.

That's *fact*... proved in tests made in a leading paper mill on patent white and bleached manila furnish, with tests and furnish conforming strictly to TAPPI specifications. More high-brightness Dicalite BP-1 (89.6 on the G.E. scale) stayed in the sheet than any other filler-pigment. BP-3 and BP-5 did almost as well, and all three were far higher than TiO_2 or any clays tested.

These tests proved, once again, what many leading paper mills have long known ... that high-brightness Dicalite Paperaids will replace significant amounts of more expensive pigments such as TiO_2, with no loss in brightness, and give you a better, smoother sheet into the bargain—*all at lower cost!*

Dependable GLC GREAT LAKES **Dicalite**®

has many advantages in paper-making

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Sprout-Waldron offers you this free technical literature

REFINERS (96-B) (185)

The precision-built 36-2 "Sprout" (96-B) is the most efficient disc type refiner in quantity of output and in quality of refined pulp per hp. input; available from 400 to 800 hp. The 36-1 S-W Refiner (185) is completely versatile in a wide range of applications; capacities from 75 to 300 hp.

REFINERS, PILOT PLANT (184)

Precision-built for accurate results which can be reliably translated into production figures, and for continuous operation in small commercial plants.

REFINERS, LABORATORY (17-A)

Used for pulping and strength development studies; reproduces end results similar to those obtained from larger refiners.

CONTINUOUS DIGESTER (196)

Creatively engineered system for producing uniform pulp economically. Really two units in one, this S-W Digester is a completely new concept in continuous pulping.

FLAT BED DRAINER (186)

Used for removing free liquor from chips, rejects, and other high freeness materials.

UNIFLOW FEEDER (187)

Developed specifically to meter and maintain a constant feeding rate to the refiner.

LABORATORY MIXER (188)

For research studies involving bleaching, mixing of coating formulas, starch cooking, cold caustic chemical pulping, and others.

FIBERPRESS (190)

Sprout-Waldron/Anderson unit removes large percentage of black liquor and dissolved solids.

STOCK PROPORTIONER (191)

Sprout-Waldron/Cowan unit provides accurate volumetric metering and proportioning of pulps to the paper machine chest.

ROTARY FEEDER VALVE (197)

Assures positive, accurate feeding into pressure vessels; minimizes steam loss; eliminates steam blow-back; reduces hp. requirements.

PULP PELLETING (F-962-A) (F-1042)

These two process flow sheets explain the recently developed Sprout-Waldron pulp pelleting process (F-962-A) and the high density storage system. (F-1042)

CONDENSED CATALOG (183)

A condensed catalog of Sprout-Waldron equipment for the Pulp and Paper industry, including equipment for conveying, mixing and blending, size reduction and classification, pelleting, bulk materials handling.

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New
ACCOBRITE®
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4028
gives superior sizing at low cost

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In many mills, this new ACCOBRITE® Rosin Size 4028 provides results equal to fortified sizes and *at lower cost.*

ACCOBRITE 4028 has low foaming qualities. One of the lightest colored sizes made, it gives a lighter, brighter board. This new size is produced as 80% solids, saving additional money in shipping and storage.

Evaluate ACCOBRITE 4028 in your own mill. Drop us a line, or telephone your Cyanamid Paper Chemicals representative. He is ready to help you with the best background of experience in the industry. And remember, Cyanamid has a *complete* line of sizes . . . light and dark, fortified and unfortified, liquid and dry. We can suggest the suitable size for all your needs.

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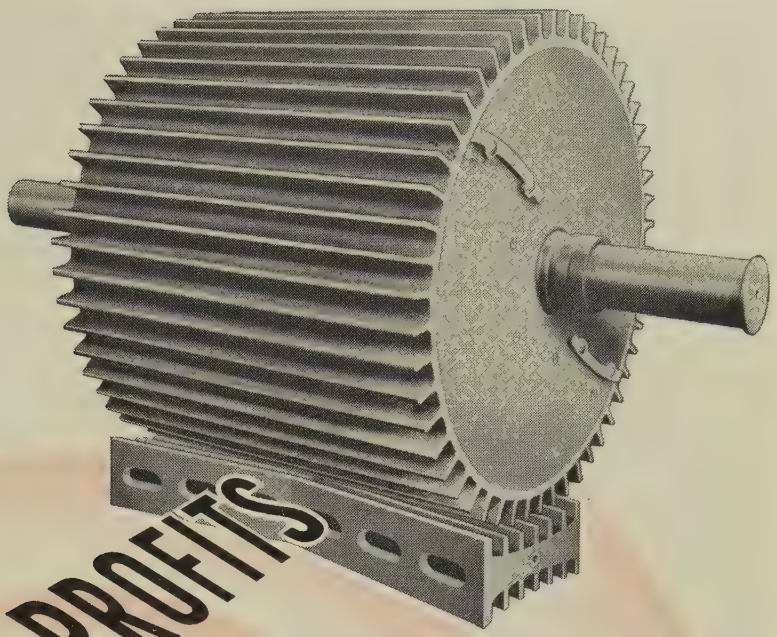

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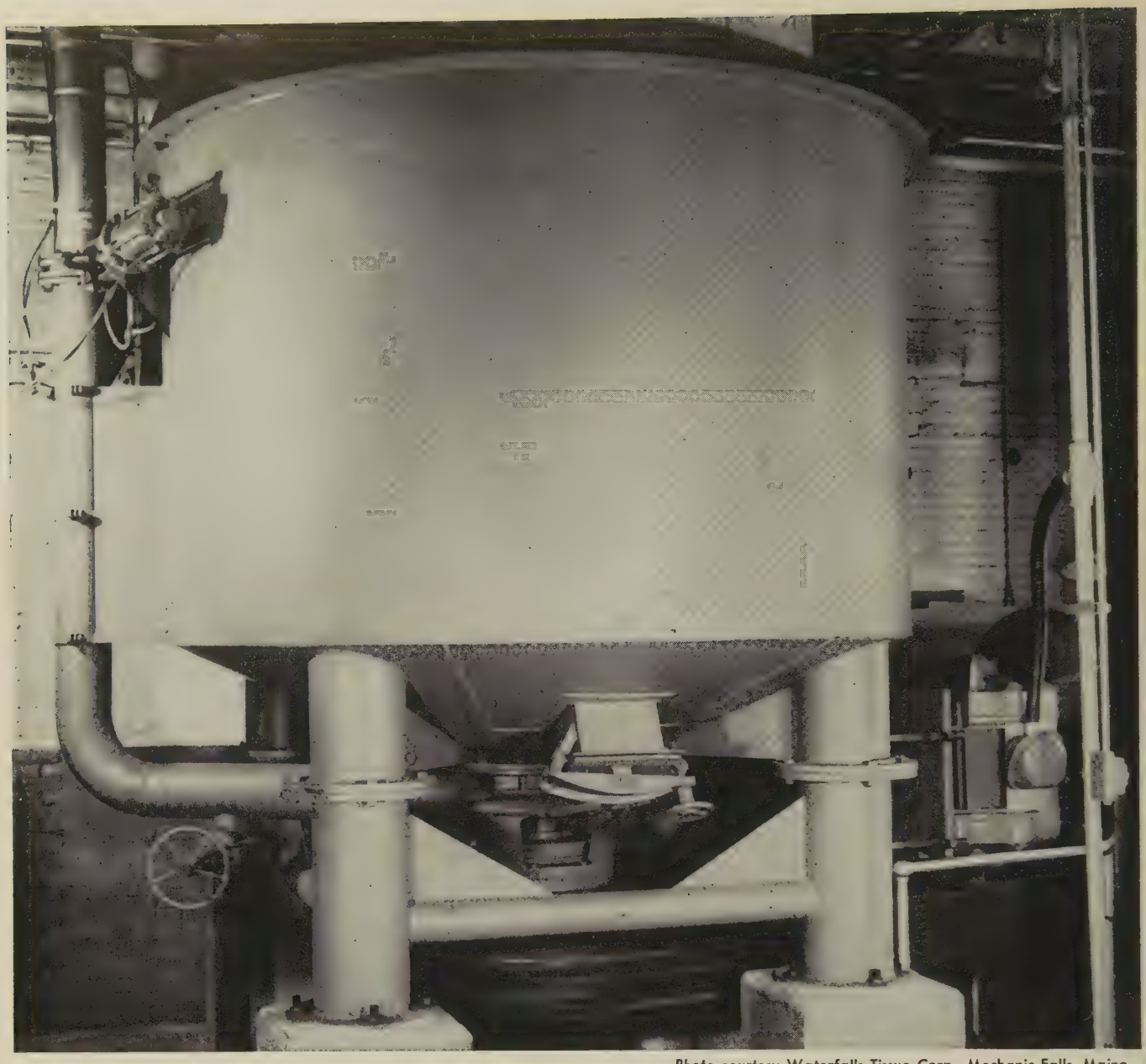

Photo courtesy Waterfalls Tissue Corp., Mechanic Falls, Maine

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AT WATERFALLS TISSUE CORPORATION
PULPING LEDGER STOCK

QUALITY — SPOT FREE
CONSISTENCY — 6.5% B. D.
TIME — FIFTEEN MINUTES

SIMILAR PERFORMANCES ARE OBTAINED ON WET STRENGTH
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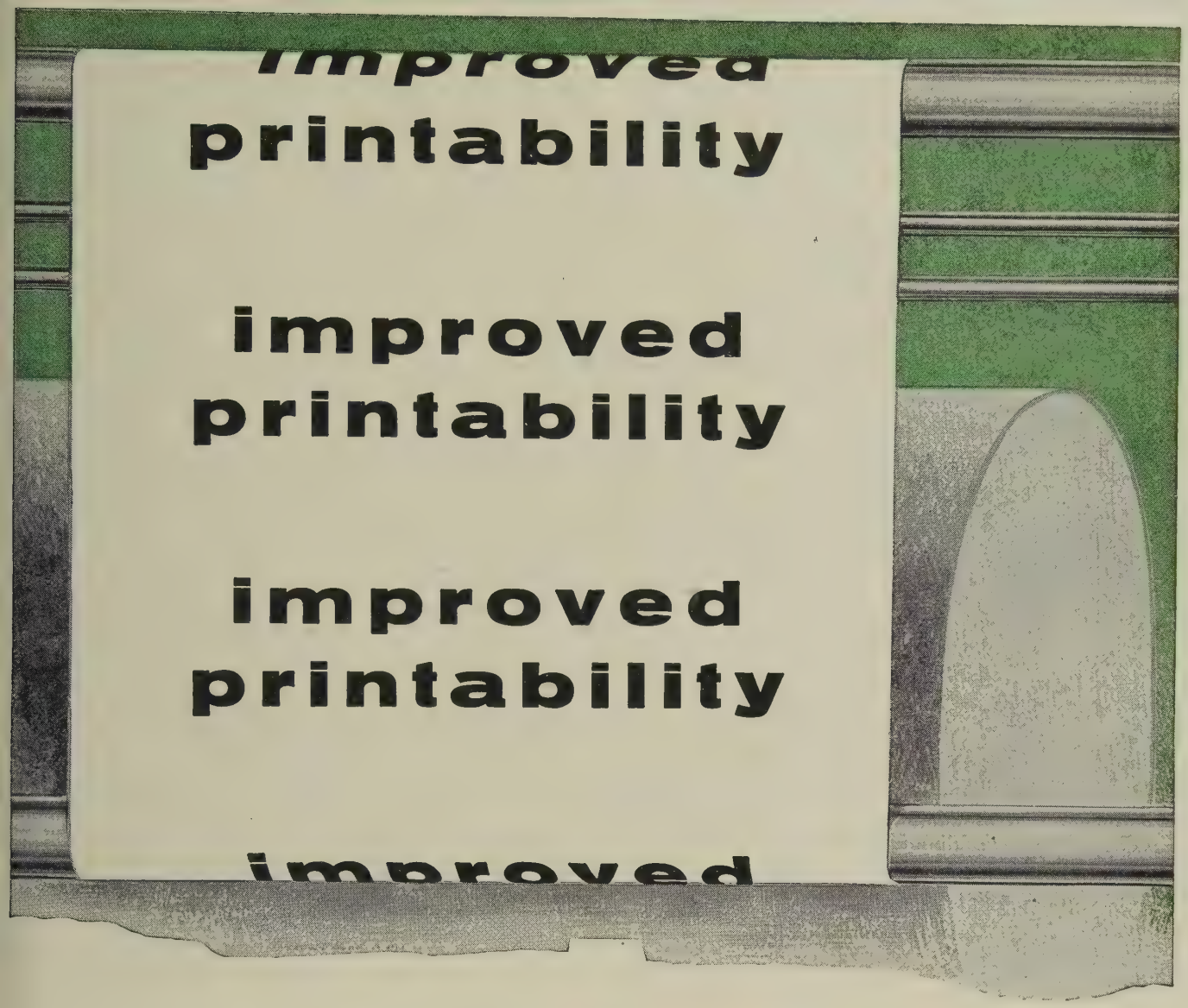

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Form—Fine beads (0.2—1.0 mm. diameter)
Transparency—Excellent
Light Stability—Good
Storage Stability—Excellent

	Softening Point	Maximum Flowable Solution
C-5V-10	123°C	20%
C-3V-10	123°C	35%
C-5V-16	134°C	20%
C-3V-20	155°C	25%
C-3V-30	180°C	20%

Softening Point: Ball and Ring Method
Solution: Ammoniacal

GELVA® *polyvinyl acetate resins by* **SHAWINIGAN RESINS®**

LAWSON HYDRAULIC CLAMP TRIMMER

Smooth... not a ripple in the cut edge when you run your thumb along a lift cut on a Lawson Hydraulic Clamp Trimmer. *Here's why:*

Proven Hydraulic Superiority... holds lift firmly, yet gently. Won't mar top sheets or disturb alignment. Extra-capacity system guards against leakage, gives uniform clamping pressure throughout the busiest work day.

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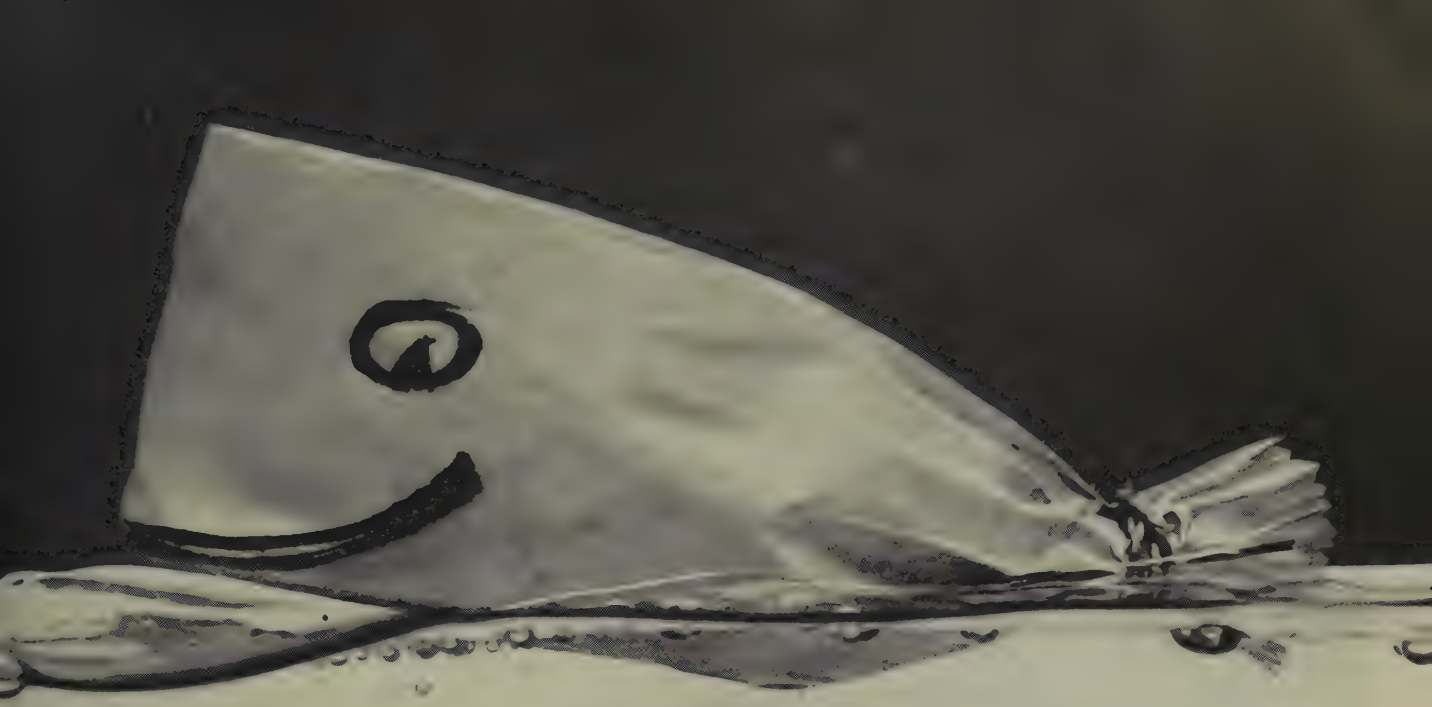
MGD



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SCRIPTITE* 33

A melamine resin supplied as a finely divided dry powder, Scriptite 33 imparts high wet strength to many paper products. Count on Scriptite 33 to increase dry tensile strength and wet rub resistance . . . to improve dry Mullen, wax pick, internal size efficiency, and dry stiffness. Scriptite 33 produces papers with strong fold endurance. For laboratory samples of Scriptite 33 and technical bulletin, write Monsanto Chemical Company, Plastics Division, Room 1151, Springfield 2, Mass.

Monsanto

*SCRIPTITE: Reg. U.S. Pat. Off.

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SCRIPTITE 40 . . . *a urea type wet-strength resin.*

SCRIPTITE 50 . . . *for unsurpassed printability and improved surface characteristics on boxboard.*

SCRIPTITE 52 . . . *in combination with formaldehyde to give water resistance to folding boxboard and to jute liner.*

SCRIPTITE 54 . . . *for outstanding water resistance and both wet and dry rub resistance.*

A NAME TO REMEMBER

. . . for pitch dispersing
. . . for slime control
. . . for size stabilizing
. . . for coating fluidizing
. . . for uniform dyeing

You will find it profitable to get all the facts about Nopcosant —Nopco's newly improved dispersant and solubilizer. Ask your Nopco representative for full details or write for complete information.

Remember, too, back of Nopco paper chemicals stands Nopco technical service—ready to assist with laboratory data and recommendations based upon your specific requirements. Nopco Chemical Company, 60 Park Place, Newark, N. J.

Properties of Nopcosant

- A fine powder of uniform particle size
- Dusts less than any other similar product
- Lightest colored product of its type
- One of the most rapidly dissolving products available
- The most nearly neutral *p*H in its chemical class

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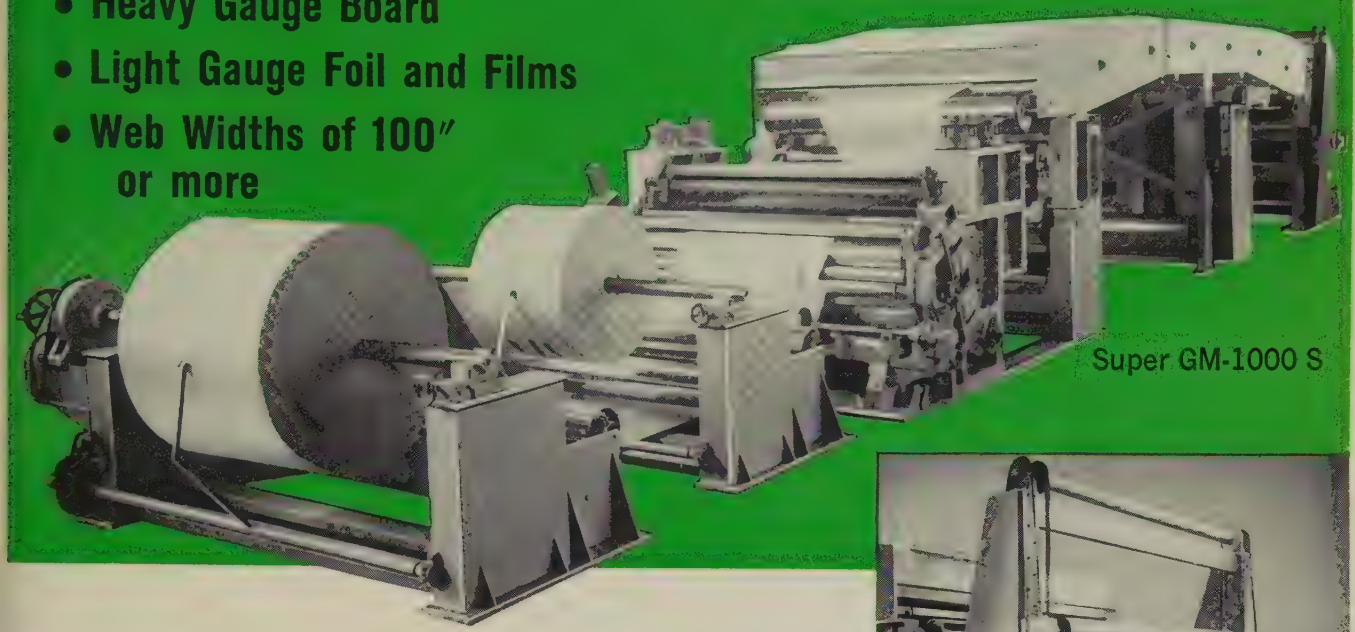
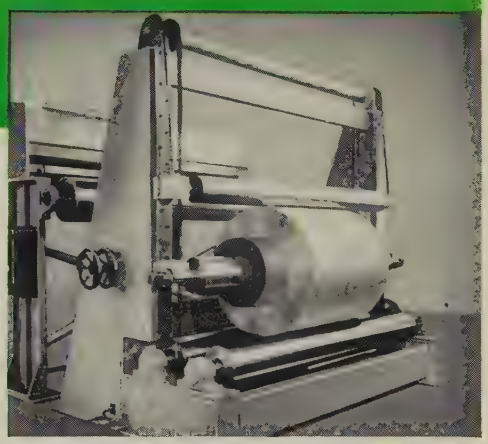
INTA-ROTO LAMINATOR & COATER

Designed and Built for Paper Mills

- **Heavy Gauge Board**
- **Light Gauge Foil and Films**
- **Web Widths of 100″ or more**



Super GM-1000 S

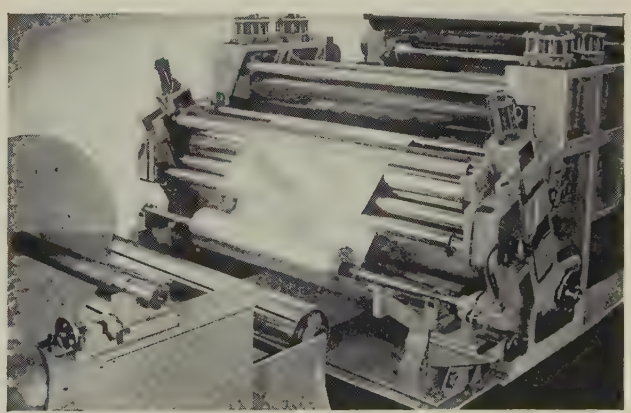


● Water cooling rolls at exit of the Super GM-1000 S drying tunnel, and surface type rewind which handles rolls up to 72″ in diameter.

More and more paper mills are extending their operations to include laminating and/or coating of the basic materials they produce.

The Inta-Roto laminator pictured above has been installed at the St. Joe Paper Company, Port St. Joe, Florida. This machine will enable St. Joe to produce high quality laminated and coated stock. The upgrading of their basic paper will mean new sales opportunities.

Inta-Roto laminators incorporate precision devices for tensioning, metering, and nip pressures to assure all-important quality control. These high speed precision machines are built on a unit basis so that you may add units to meet production changes or expansions.



● The Super GM-1000 S compact, precision station for application of adhesive and hot melts with two combining roll units.

INTA-ROTO

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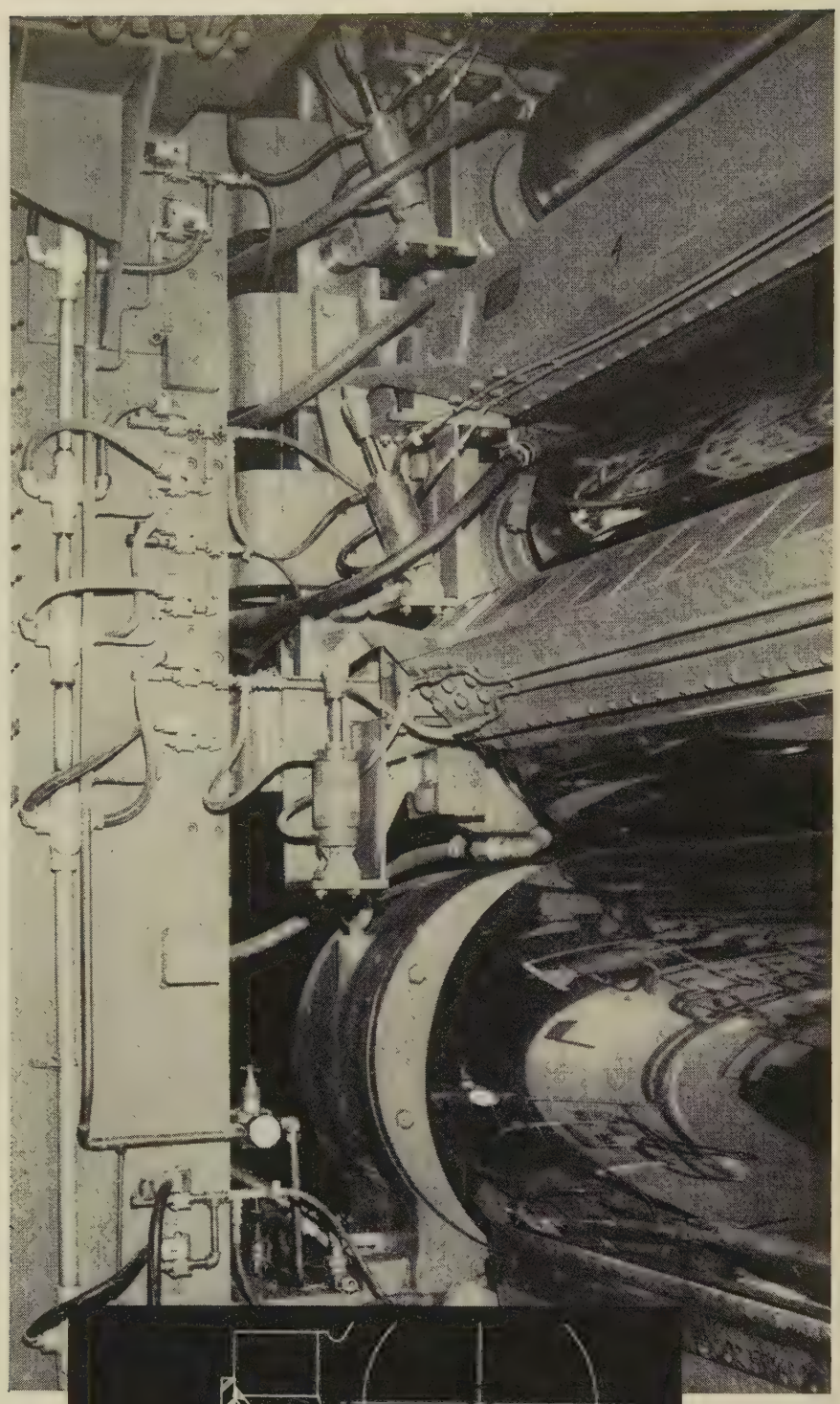

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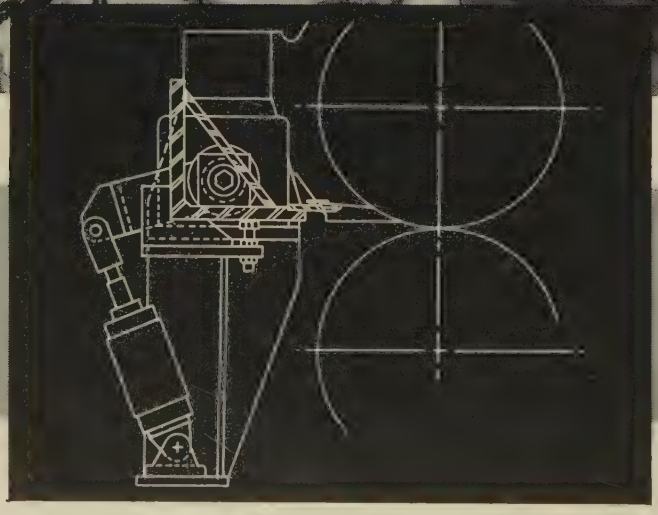

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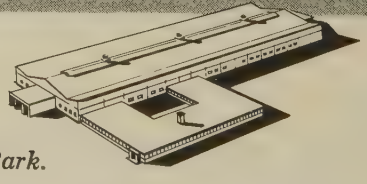

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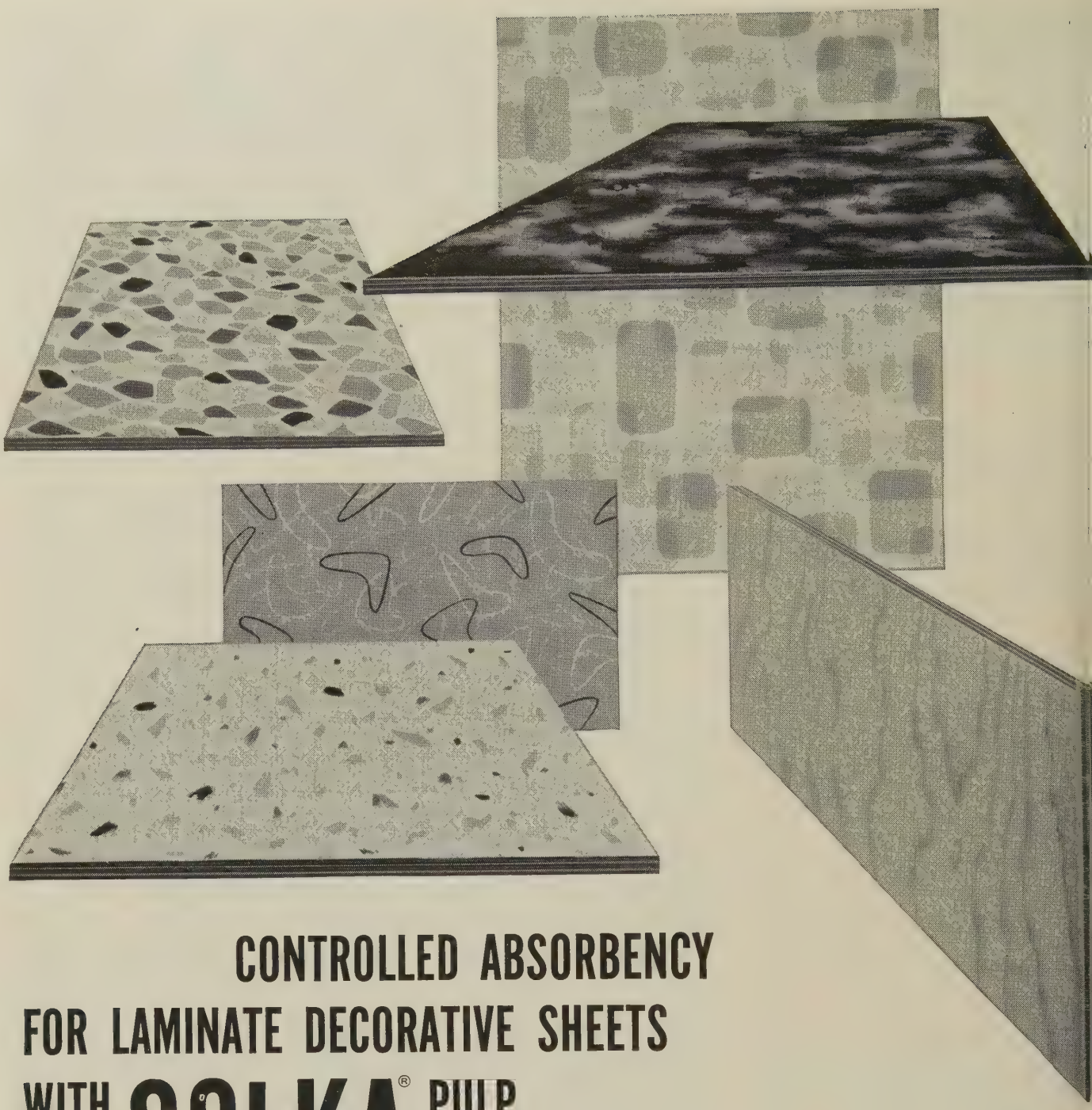

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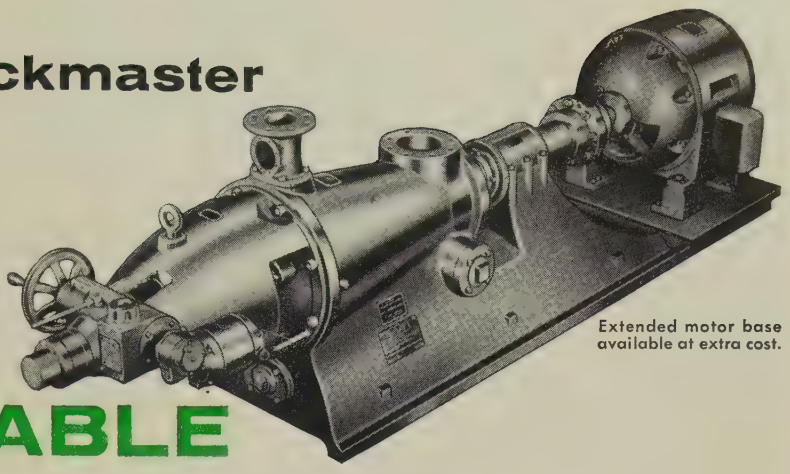

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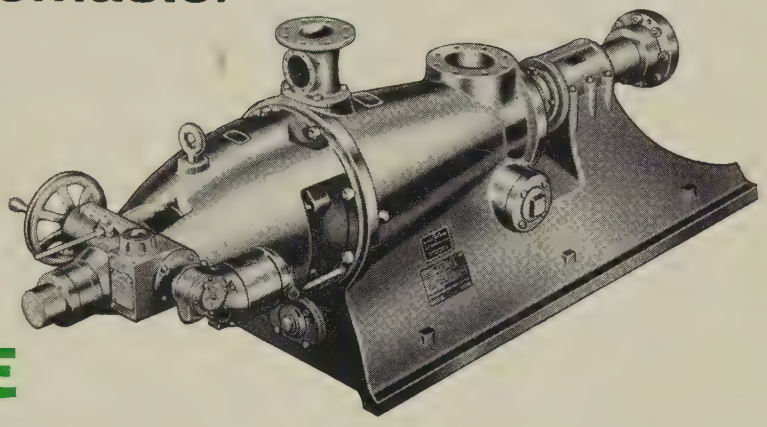

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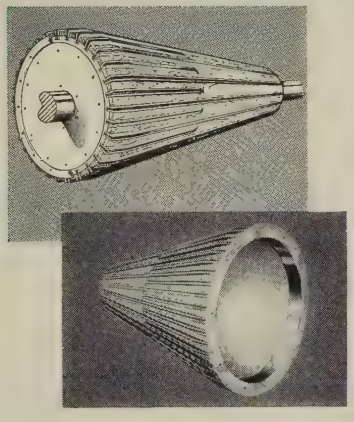

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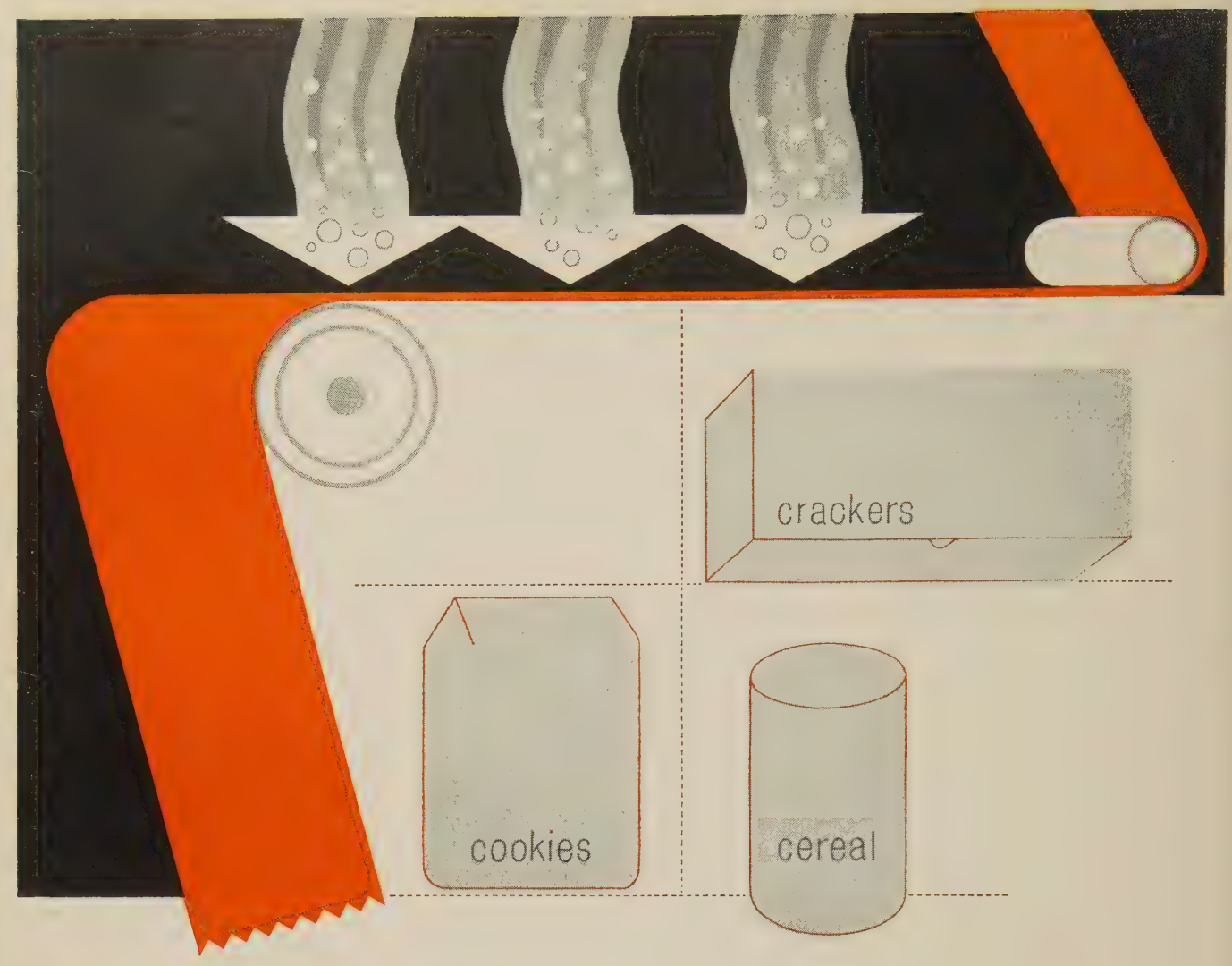

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The Sivola Sulphite Cooking and Recovery Process

T. A. PASCOE, J. S. BUCHANAN, E. H. KENNEDY, and GEORGE SIVOLA

This paper describes briefly the history and background of the process and then continues with paper mill laboratory results of cooking various species of wood by single and multistage digestions and a description of the chemical conversion process. Three pulp and paper research laboratories—one in Finland, one in Sweden, and one in this country—have made detailed studies of this cooking process both on a laboratory and a plant digester scale. The research group of the Nekoosa-Edwards Paper Co. has concentrated on pulping Lake States hardwoods, including mixed oak, aspen, birch, and maple using the two stage (bisulphite-soda) digestion. Jack pine pulping by this process was also investigated. This cooking process consists of a sodium bisulphite first stage followed by an alkaline stage, without interrupting cooking in the same vessel. The major portion of delignification is accomplished in the first stage which is a true bisulphite cook (pH = 4.0). Sodium carbonate is injected into the digester for the second stage to produce a pH in the range of 7.5 to 9.5. By adjusting the relative time of the two cooking stages, the temperature, and the pH of the alkaline stage, a wide range of pulp types can be prepared from all of the wood species investigated. The well-established advantages of high combined sulphur dioxide (or bisulphite) pulping are combined with the effects of an alkaline cook to yield a very versatile process whereby pulps can be made having strength comparable to kraft, but yet are easy bleaching, as conventional sulphite. Since the literature contains very little and some contradictory work on the effects of thiosulphate in soluble-base cooking liquor on pulp properties, a study was made with aspen to ascertain these effects, their degree of damage, and the quantities of thiosulphate that may be tolerated in the recovered cooking liquors. It was shown that small quantities of thiosulphate in high free sulphur dioxide pulping liquor causes darkened pulps and increased bleach demand. Thiosulphate present during high combined sulphur dioxide pulping is less serious and larger amounts can be tolerated. In this two-stage cook, thiosulphate can be present at concentrations up to 8% $Na_2S_2O_3$ based on oven-dry wood (30% of cooking liquor sodium as $Na_2S_2O_3$) without undesirable effects. It has been shown that thiosulphate can be classified as an active delignifying agent under proper conditions. The Sivola conversion process is described in detail with the accompanying flow diagrams which show the available chemical streams in and out of the system and the functions of the component parts. Flow diagrams also show the possibilities of using the recovery process for mixed spent liquors involving single-stage bisulphite plus sulphur dioxide or single-stage bisulphite or two-stage bisulphite-soda with kraft, soda, or NSSC digestions.

THE Combustion Engineering Company's first contact with the Sivola sulphite cooking and recovery process was in late 1949 and early 1950. At that time, Rauma-Raahe, Oy, now Rauma-Repola, Oy, of Rauma, Finland, decided to convert a calcium-base sulphite mill to a sodium-base sulphite mill for making and dissolving high grade paper pulps. They retained George Sivola, of Helsinki, as process consultant and in conjunction with Chemibau of Germany, the secondary recovery process equipment was designed and built.

Combustion Engineering was awarded the contract for the primary recovery furnace and boiler which is essentially a standard 200-ton per day kraft recovery unit.

The new plant and equipment was started in June, 1952, but it was well into 1953 before troubles in design and operation were overcome and full plant production realized. No major changes in design or equipment had to be made. Improper selection of the materials of construction for corrosion prevention was responsible for many of their troubles.

The plant was designed for 50,000 metric tons of pulp per year but production was soon expanded to 70,000 tons, and an early expansion above this figure is contemplated. Here is a plant unit of medium sized tonnage which has been successfully operating primary and secondary waste heat and chemical recovery from a sodium-base bisulphite digestion for 5 years.

The Sivola sulphite cooking and recovery process and equipment was originally designed and selected to produce either dissolving or high grade sulphite pulp at Rauma from spruce and balsamwoods. The cooking process consisted of a two-stage cook, the first being a sodium bisulphite plus free sulphur dioxide stage followed by an alkaline sodium carbonate stage. A high degree of refinement in the secondary recovery process was therefore necessary. Some degree of simplification and reduction in cost of the secondary conversion equipment is possible when the spent liquor from a lower grade or an unbleached pulp is being processed.

It appeared that here was an opportunity to offer the old calcium base or new sodium-base sulphite mills a practical and successful integrated process for the cooking of pulp and the recovery of chemicals and heat. At the same time, the quality of the pulp could be upgraded, stream and air pollution reduced to a minimum, and the mill could use either hard or softwoods.

An agreement was entered into with Mr. Sivola whereby Combustion Engineering was licensed under his cooking and recovery patents to offer such an integrated process. The Sivola sulphite recovery or conversion process is licensed under U. S. pat. 2,730,445 to Combustion Engineering, Inc., in the United States, Canada, and Mexico. It was developed primarily for the recovery or conversion of chemicals from the two-stage bisulphite-soda digestion process but may be applied to the recovery of chemicals from any type of sulphite pulp digestion or in combination as cross recovery with kraft or soda pulp digestions, as will be shown later.

BASIC PRINCIPLE AND OBJECTIVES

The Sivola conversion process is primarily based on

T. A. PASCOE, Manager of Research, and J. S. BUCHANAN, Research Chemical Engineer, Nekoosa Edwards Paper Co., Port Edwards, Wis.; E. H. KENNEDY, Chemical Engineer, Paper Mill Equipment Engineering Dept., Combustion Engineering, Inc., New York, N. Y., and GEORGE SIVOLA, Inventor and Process Consultant, Helsinki, Finland.

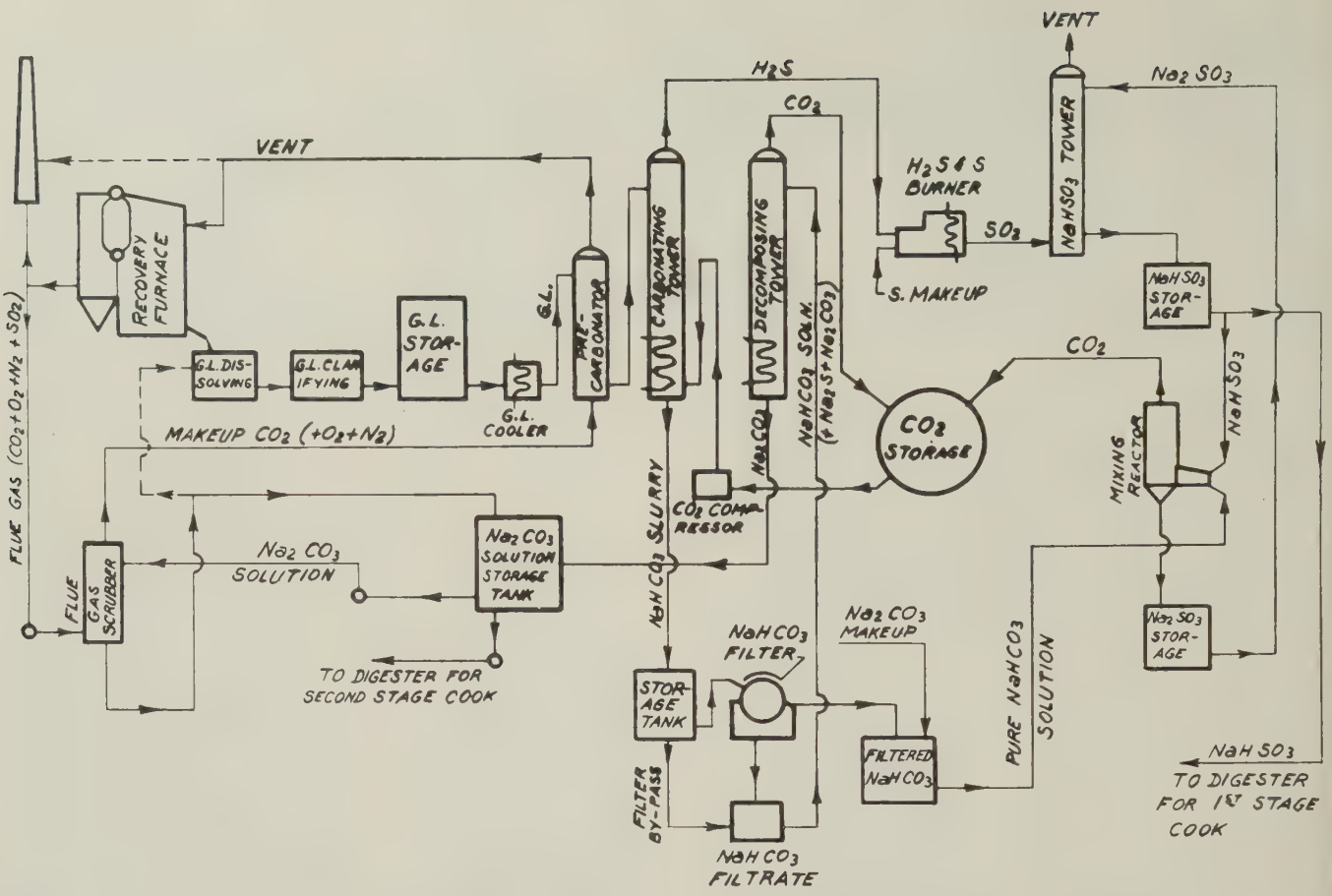

Fig. 1. Sivola-Combustion flow diagram for the recovery of waste heat and chemicals from two-stage neutralized sodium bisulphite cooks. (U. S. pat. 2,730,445)

the carbonation of the clarified green liquor from the dissolving tank of the primary recovery unit.

The objectives of the conversion process are severalfold:

1. To convert the chemicals in the green liquor to relatively pure forms for making the digester cooking liquors.
2. To keep the formation of sodium thiosulphate, sodium sulphate, and free sulphur to minimum amounts.
3. To reduce air and stream pollution to a minimum.
4. To return nearly pure carbon dioxide to the cycle for carbonation and in sufficient amount so that relatively little carbon dioxide make-up is required from the flue gas.
5. To liberate the hydrogen sulphide at high concentrations for burning to sulphur dioxide.
6. To supply the streams from the process at high concentrations so that excess water will not have to be handled and evaporated.
7. To recover the highest possible percentage of sodium and sulphur from the incoming green liquor.
8. To provide a flexible and versatile process by furnishing several available streams for various individual sulphite cooking processes or for integration with kraft, soda, or NSSC digestions.

Green Liquor

The incoming clarified green liquor from the primary recovery furnace to the conversion process has the following typical analysis if a two-stage bisulphite-soda digestion is used; that is, a bisulphite-soda cook.

Refer to Fig. 1 for clarification of the following description of the conversion process.

The Carbon Dioxide Cycle

After the green liquor is clarified and cooled, it enters a precarbonating tower. Here it comes in contact with

		Grams per liter as Na_2O
Na_2S		74.3
Na_2CO_3		68.0
NaOH		2.0
Na_2SO_3		0.5
$Na_2S_2O_3$		4.6
Na_2SO_4		8.1
	Total	157.5

scrubbed and washed flue gas from which dirt and sulphur dioxide have been removed. In the precarbonating tower enough carbon dioxide from the flue gas is absorbed to make up for carbon dioxide losses in the cooking and recovery system. Leaving the precarbonator, the flue gas is vented to the stack or primary recovery furnace.

From the precarbonator, the green liquor enters the carbonating tower where it is reacted with nearly pure carbon dioxide recovered in various stages of the conversion and cooking processes. The carbon dioxide is taken from the carbon dioxide holder or gasometer and forced through the carbonating tower by a compressor operating at about 2 atm. pressure.

In the carbonating tower, a 20 to 25% excess carbon dioxide over that theoretically needed is used to strip the green liquor solution of the hydrogen sulphide, which is liberated. This excess carbon dioxide is later wasted through the bisulphite tower vent and has to be made up from flue gas in the precarbonator.

As will be explained later, carbon dioxide is recovered from three separate steps in the conversion cycle and elsewhere: (1) from the decomposition of sodium bi-

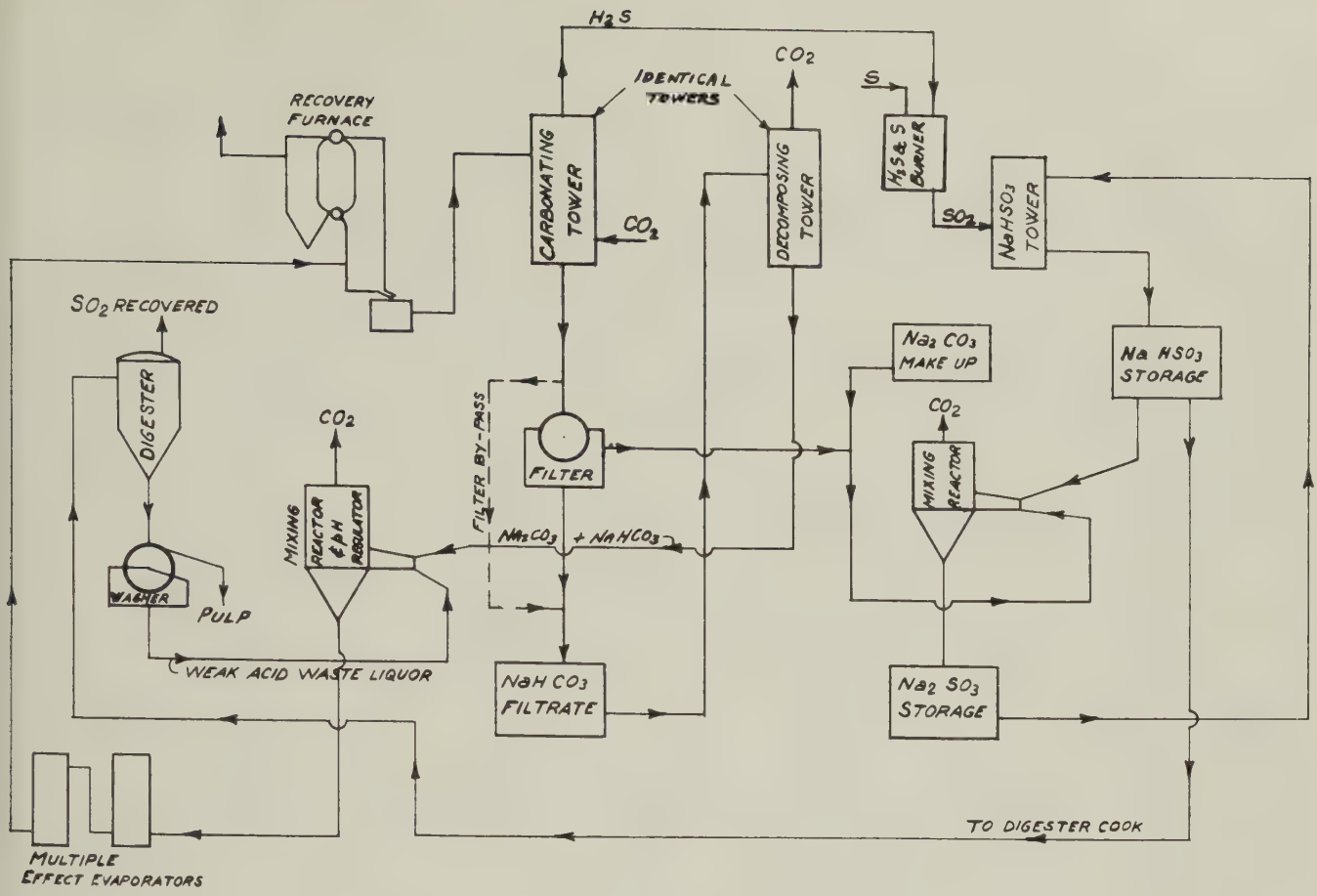

Fig. 2. Sivola recovery process for sodium bisulphite digestions. Single-stage cooks

carbonate (2) from the reaction of sodium bisulphite with a sodium carbonate-sodium bicarbonate mixture, and (3) from neutralization of the acid cooking liquor in the digester at the end of the first cooking stage with a sodium carbonate-sodium bicarbonate mixture.

These streams are led to and stored in the carbon dioxide gas holder.

The Green Liquor Cycle

In the carbonating tower, the precarbonated green liquor comes in contact with carbon dioxide, and the sodium sulphide and sodium carbonate are converted substantially to sodium bicarbonate, a portion of which is precipitated and removed as a crystal slurry. Precipitation is accomplished by removing the heat liberated during the reaction and by keeping the concentration of the entering green liquor equal to that leaving the dissolving tank, which is about 150 g.p.l. Na_2O.

Hydrogen sulphide is liberated during the reaction at a fairly high concentration, being diluted only by the necessary excess of carbon dioxide used for stripping the hydrogen sulphide from the carbonated solution. Conversion in the carbonating tower is about 95%.

The Bicarbonate to Carbonate Cycle

The bicarbonate crystal slurry leaving the carbonating tower is then sent to a rotary drum-type filter where the necessary amount of crystals is separated from the mother liquor and washed. The purpose in separating the crystals from the mother liquor and washing them is to obtain a relative pure chemical for the preparation of the bisulphite cooking liquor used in the first or acid cooking stage. By doing this, the formation of thiosulphates and free sulphur is kept at a minimum, which condition is necessary for making a high grade easily bleached pulp. This is especially true if a single-stage bisulphite digestion only is being made.

The mother liquor and the remainder of the crystals are sent to the decomposing tower or a separate decomposer where they are heated, causing the evolution of carbon dioxide which is led back to the carbon dioxide storage holder. Conversion here may be in the range of 75 to 85 % without the use of an excessive amount of steam.

The decomposing tower is a duplicate of the carbonating tower, this being necessary to secure continuity of plant operation. The towers are regularly switched so that the tower being used for the decomposing step is being, at the same time, cleaned or "backwashed" of precipitate which may have been deposited on the passettes and heat transfer tube bundles while the tower was operating as a carbonator. When being used as a decomposer, steam is passed through the tube bundles instead of cooling water.

A modification of equipment here may be made by using the two towers as carbonating towers only, one, a spare for cleaning while out of service, in which case a separate decomposing chamber for decomposing only is provided. The mother liquor or filtrate from the filter contains a little unconverted sodium sulphide. In passing through the decomposer some of this sodium sulphide is converted to carbonate so that the effluent from the decomposer is mostly sodium carbonate with some undecomposed sodium bicarbonate. This effluent from the decomposer is used as the injection alkali to convert the bisulphite cooking liquor to alkaline cooking

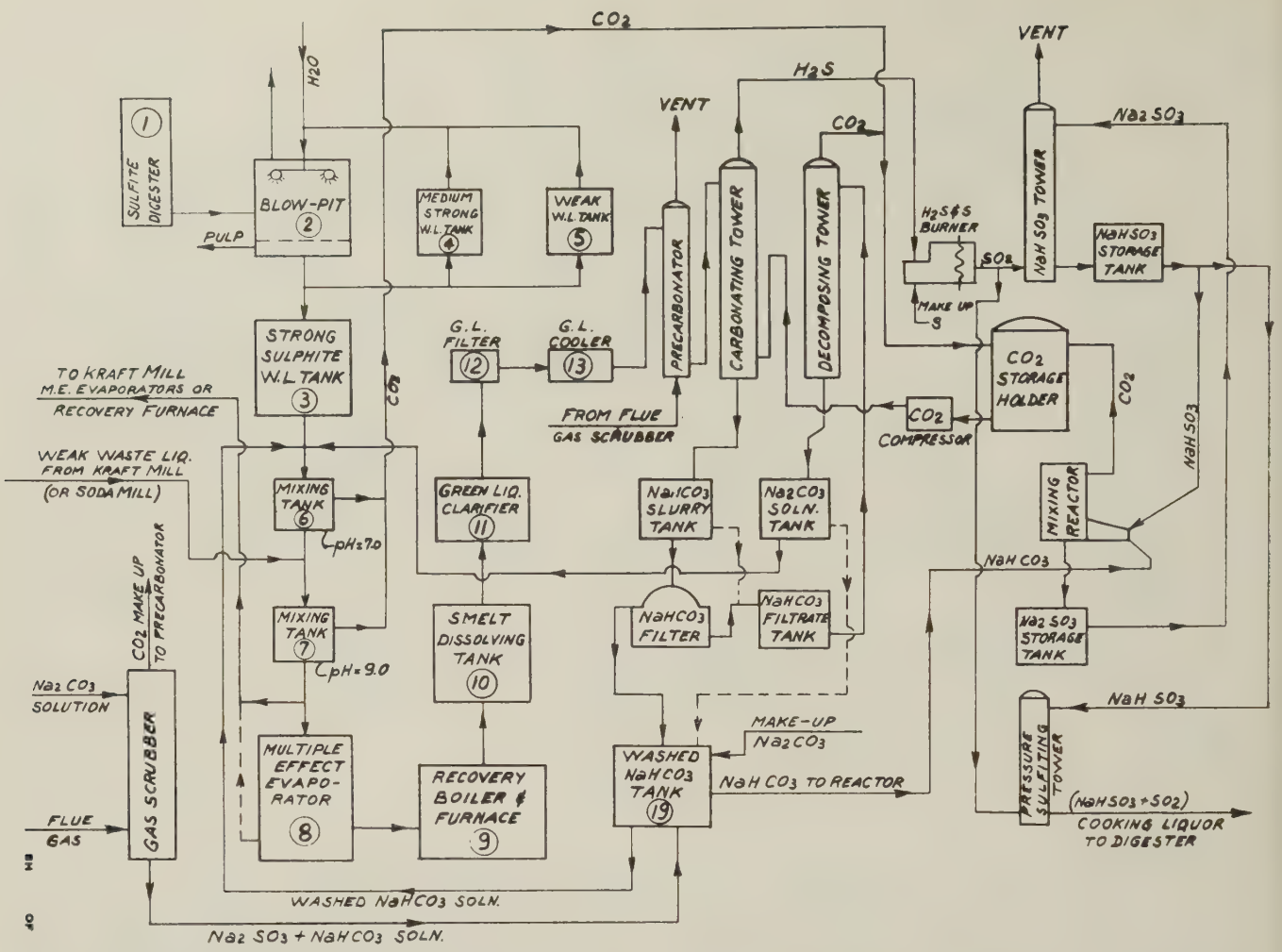

Fig. 3. Sivola chemical recovery process for the integration of kraft and single-stage (sodium bisulphite + SO_2) cooks

liquor for the second stage of the digester cook when a bisulphite-soda digestion is being used. Since the second cooking stage is alkaline, the slight amounts of sodium sulphide or thiosulphate in this cooking liquor will not adversely affect pulp qualities or bleachability.

The Hydrogen Sulphide-Sulphur Cycle

Hydrogen sulphide liberated from the carbonating tower at 40 to 60% concentration is burned to sulphur dioxide in a specially designed furnace, and waste heat boiler. Sulphur to make up the losses in the cooking and recovery system is also burned in this same furnace to sulphur dioxide. Sulphur make-up is in the range of 90 to 100 lb. per ton of pulp at about 48% yield. After cooling to the proper temperature, the sulphur dioxide is reacted with incoming sodium sulphite in the bisulphite acid-making tower.

The Bicarbonate-Bisulphite-Sulphite Cycle

The important piece of equipment in this cycle is the mixing reactor whose name describes its function. Into the mixing reactor are led two streams: (1) the lightly washed bicarbonate crystals from the filter, and (2) a concentrated solution of sodium bisulphite from the bisulphite storage tank. Products of the reaction are sodium sulphite and pure carbon dioxide. The carbon dioxide is returned to the carbon dioxide storage holder and the sodium sulphite is sent to the bisulphite tower to be reacted with sulphur dioxide to make sodium bisulphite. Note that the stream from the bisulphite storage tank is divided in two parts, half being sent to the mixing reactor and half to the digesters for the cooking liquor of the first cooking stage of a bisulphite-soda digestion.

The sodium losses occurring in the cooking and recovery system are made up in the form of sodium carbonate which may be added to the washed bicarbonate crystals going to the reactor or sodium sulphate in the form of salt cake, which is added to the furnace. The sodium make-up is in the same range as the kraft cooking and recovery cycle, being about 100 lb. Na_2CO_3 per ton of pulp at about 48% air dry yield.

The Digester-Carbonate Cycle

Carbon dioxide is recovered for the conversion process from a third point which is outside the conversion system itself. At the end of the first acid cooking stage in the digester with sodium bisulphite, a sodium carbonate solution from the decomposing tower or separate decomposer is injected into the digester for the second cooking stage. In so doing the pH value of the digester cooking liquor is raised from, say pH 4 to 8.5, and carbon dioxide is liberated by the reaction of the injected carbonate and the organic acids and residual bisulphite in the cooking liquor. This liberated carbon dioxide is scrubbed free of sulphur dioxide in an appropriate tower and returned to the carbon dioxide storage holder.

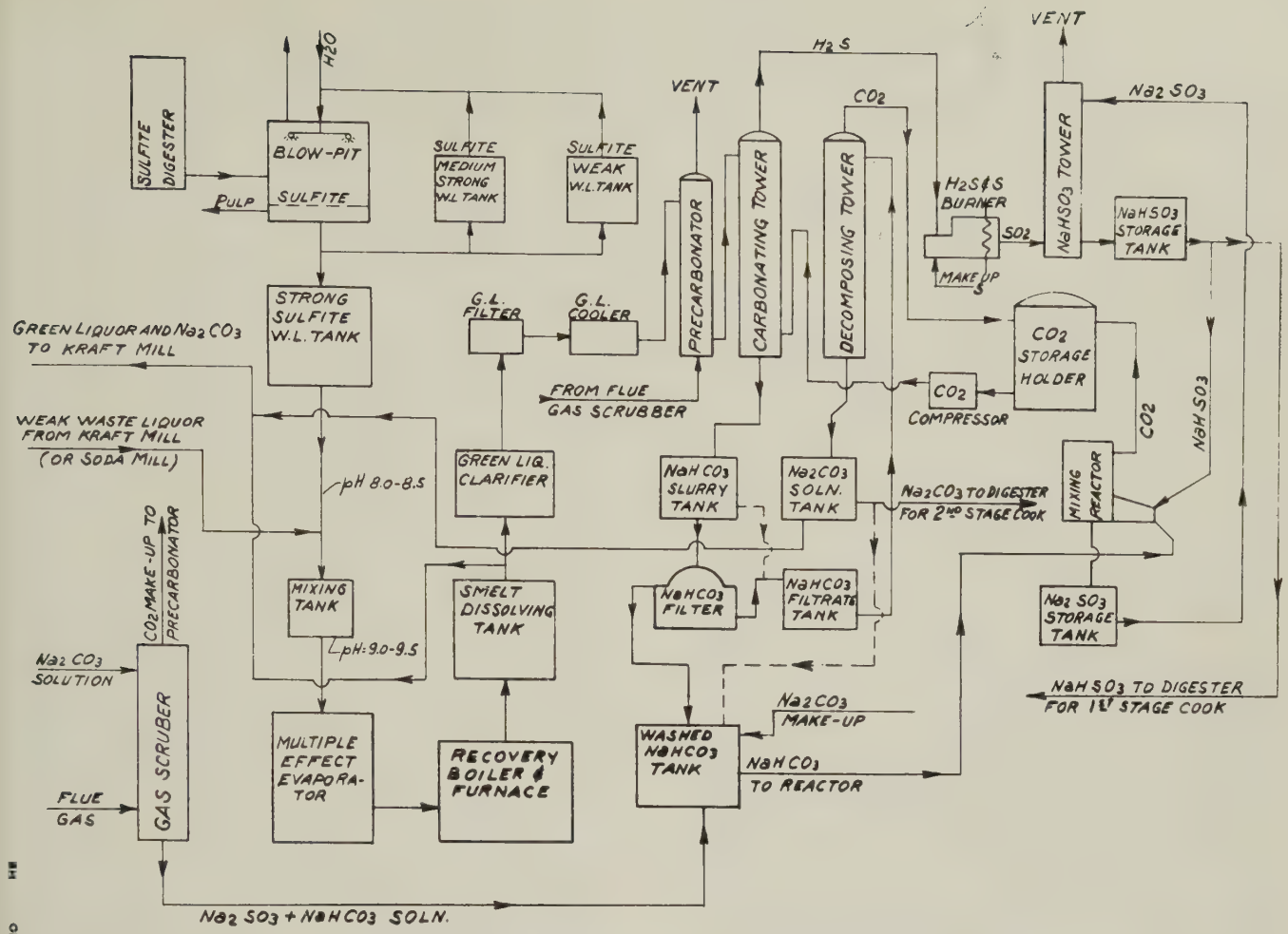

Fig. 4. Sivola chemical recovery process for the integration of kraft and two-stage (sodium bisulphite and sodium carbonate) cooks

Applications of the Conversion Process

From a glance at Fig. 1, it can be seen that several chemical streams are available from the complete cycle; namely, pure sodium bicarbonate, relatively pure sodium carbonate, sodium sulphite and sodium bisulphite, sulphur dioxide and carbon dioxide. From this array of chemicals the following digestions can be made:

I. Bisulphite Chemical—Single Stage.
   (a) Sodium bisulphite plus free sulphur dioxide.
   (b) Sodium bisulphite.
II. Buffered Sulphite—Semichemical—Single Stage.
   (a) Sodium sulphite plus sodium carbonate.
   (b) Sodium sulphite plus sodium bicarbonate.
III. Bisulphite plus free sulphur dioxide plus Soda—Chemical—Two Stage.
IV. Bisulphite plus Soda—Chemical—Two Stage.
V. Bisulphite plus sulphur dioxide plus Soda—Chemical—Three Stage.
VI. Integration of (bisulphite plus sulphur dioxide) or Bisulphite with Soda or Kraft—Chemical Digestions.
VII. Integration of Bisulphite plus Soda with Soda or Kraft—Chemical Digestions.
VIII. Integration of Buffered—Semichemical with Soda or Kraft Chemical Digestions.

The flow diagram of the conversion process for some of the above digestions or combinations are illustrated in Figs. 2, 3, and 4.

WORK DONE AT NEKOOSA-EDWARDS PAPER CO.

Pulping work reported in this section is a summary of a broad program at Nekoosa-Edwards in the development and evaluation of two-stage bisulphite-soda digestion with a threefold end in mind. The necessary end requirements were: (*1*) a process which could be adapted to prepare pulps which would have a maximum number of properties suiting them for the manufacture of high quality fine papers, (2) a pulping process that would be able to utilize a maximum amount of present calcium-base sulphite mill existing equipment, and (3) a pulping method that could be integrated with a sound chemical recovery process to eliminate any question of air and water pollution and would be economically feasible. The primary goal was to prepare a pulp type having as many as possible of the following properties: cleanliness, good strength at high bulk, and slow beating enough to permit working for good "handle" and formation, easy bleaching to high brightness without loss of strength, high opacity, and minimum brightness reversion. With these properties of foremost importance, this work largely involved the adapting and development of two-stage pulping through a narrow area to conform to the above requirements.

The Lake States hardwoods were quite thoroughly investigated because of their abundance in our area. Jack pine was of importance because of its low cost in relation to spruce and balsam, and offered the possibility of substituting this species for the presently used spruce and balsamwoods. Comparison of the two-stage pulps was made with kraft pulp, conventional

Table I. Bisulphite-Soda Cooking Data—Hardwoods

Cook no.	Acid stage: Liquor pH	Acid stage: Time at 160°C., hr.	Alkaline stage: Liquor pH	Alkaline stage: Time at 160°C., hr.	Total Cooking time hr.	$KMnO_4$ no.	Pulp Yield[a]: Accepts,[b] %	Pulp Yield[a]: Rejects, %	Pulp Yield[a]: Total, %
Aspen									
8	3.9	2.00	10.7	2.0	6.00	9.0	47.4	0.3	47.7
9	3.7	2.00	8.5	2.0	6.00	12.5	52.4	0.4	52.8
10	3.9	2.25	9.0	1.5	6.25	13.7	51.7	0.3	52.0
11	3.7	2.00	7.2	2.0	6.00	14.2	53.5	1.0	54.5
Mixed Oak									
12	3.3	2.00	9.5	2.0	7.50	10.5	36.3	0.2	36.5
13	3.4	2.00	11.0	2.0	7.00	11.7	35.2	0.4	35.6
14	3.0	2.25[c]	9.5	2.0	7.75	13.2	39.7	0.2	39.9
15	3.3	3.25[d]	9.5	2.0	8.25	17.0	40.3	2.1	42.4
16	(Kraft—20% A.A.—170°C.)				4.15	13.0	44.0	0.9	44.9
Birch									
17	4.0	2.3	9.0	1.5	6.33	15.3	46.8	0.6	47.7
Hard Maple									
18	4.3	2.75	9.0	1.5	6.75	16.5	46.4	0.3	47.6
Soft Maple									
19	4.0	2.75	8.7	1.5	6.75	16.8	46.7	0.5	47.2
Elm									
20	3.8	2.50	9.2	1.0	8.5	15.8	47.6	0.2	47.8

[a] Calculated on moisture-free basis.
[b] Accepts through 0.014 in screen plate.
[c] Maximum temperature 155°C. instead of 160°C.
[d] Maximum temperature 150°C. instead of 160°C.

high free sulphur dioxide sulphite pulps and high combined sulphur dioxide sulphite pulps.

An important consideration is selection and evaluation of a recovery process for soluble-base sulphite spent liquor has been the amount of sodium thiosulphate tolerated in the cooking liquor produced by the recovery. Most present proposed recovery processes involve a sulphiting step, and sodium thiosulphate is one of the reaction products formed when the liquor to be sulphited contains sodium sulphide. Sulphur dioxide and sodium sulphide will react to produce sodium thiosulphate and other polythionates. A relatively large amount of the elaborate design and expense of a sulphite recovery process is a result of the designer's efforts to minimize the amount of sodium sulphide in the liquor to be sulphited and accounts for a substantial share of the price of such a unit. Since the effect of thiosulphate in sodium sulphite or bisulphite cooking can be translated directly into monetary terms of capital expenditure and operational complexity, it appeared desirable to learn just what these effects are, how deleterious they are, and what concentrations of thiosulphates are required to produce them.

At various stages throughout this broad investigation, six commercial scale digester cooks of mixed oak were made by the two-stage bisulphite-soda process in the Port Edwards sulphite mill to prepare sufficient pulp for processing through the pulp mill and bleach plant.

Summary of Results and Conclusions

Two-stage pulps can be produced with a wide variety of characteristics because of the versatility of the process. This flexibility is primarily a result of employing a second stage which is alkaline. The time-temperature combination of the acid stage, and the time-pH combination of the alkaline stage are the main variables which may be altered to produce pulps having widely different characteristics.

In general, these pulps have the strength of kraft pulps, but are light colored, and easily bleached to high brightness without loss of strength. They can be made either fast or slow beating. The slow beating pulps have higher opacity (C/R) than kraft pulp. The yield of bleached two-stage pulp is about the same as for kraft pulp from the same species. Neither very high temperature or pressure is required for two-stage digestion. Cooking time is longer than kraft, but shorter than conventional sulphite.

Sodium thiosulphate has been shown to be an active pulping agent, its effectiveness being a function of the

Table II. Multistage Bleach Data—Hardwoods

Cook No. →	Aspen 10	Aspen 11	Mixed oak 14	Mixed oak 15	Birch 17	Hard maple 18	Soft maple 19
$KMnO_4$ number	13.7	14.2	13.2	17.0	15.3	16.5	16.8
1st stage, % Cl_2 consumed as Cl_2	2.0	2.5	2.4	5.2	3.5	3.0	3.0
2nd stage, % NaOH as NaOH	2.0	2.0	2.0	2.0	2.0	2.0	2.0
3rd stage, % Cl_2 consumed as $Ca(OCl)_2$	1.4	1.4	1.4	1.3	1.4	1.4	1.5
Total % Cl_2	3.4	3.9	3.8	6.5	4.9	4.4	4.5
Brightness, % G.E.	86.0	85.8	88.6	88.7	86.8	86.7	87.5
P.C. number	0.51	...	...	...	0.27	0.72	0.55
Bleaching yield, (based on unbleached pulp), %	94.9	93.2	94.1	89.1	95.8	94.0	92.0
Over-all bleached pulp yield (based on moisture-free wood), %	49.0	49.8	37.4	36.0	44.9	43.6	43.0

Table III. Bisulphite-Soda Cooking Data—Jack Pine

Cook no.	Acid stage: Final liquor pH	Acid stage: Time at 160°C., hr.	Alkaline stage: Liquor pH	Alkaline stage: Time at 160°C., hr.	Total cooking time, hr.	$KMnO_4$ no.	Pulp yield[a]: Accepts,[b] %	Pulp yield[a]: Rejects, %	Pulp yield[a]: Total, %
1	3.5	3.25	10.0	2.0	7.25	14.9	40.5	0.5	41.0
2	3.7	3.25	9.5	3.0	8.25	16.5	43.2	0.9	44.1
3	3.6	3.25	9.5	2.0	7.25	19.6	44.9	1.5	46.4
4	3.6	2.75	9.0	3.0	7.75	22.1	46.4	1.9	48.3
5	2.6	3.25	7.6	1.0	6.75	23.5	50.0	2.7	52.7
6	3.5	3.25	8.0	2.0	7.25	24.1	47.7	6.2	53.9
7	Kraft (20.0% A.A.—170°C. top)				4.25	21.2	43.6	0.3	43.6

[a] Calculated on moisture-free basis.
[b] Accepts through 0.014 in. screen plate.

cooking process, or probably more accurately stated, a function of cooking pH. In the range of high combined sulphur dioxide pulping a moderate amount of thiosulphate is permissible, allowing for a considerable amount of flexibility in chemical recovery design. True acid pulping (high free sulphur dioxide) is extremely sensitive to the thiosulphate effects and offers little encouragement in the possibility of recovery simplification. Thiosulphate present in a two-stage cook causes pulps of lower bleach demand and high unbleached pulp brightness to be produced up to thiosulphate concentrations of about 8% based on the moisture-free wood weight, permitting maximum flexibility in recovery design with regard to the formation of sodium thiosulphate.

Experimental Procedure: Two-stage Digestions

Experimental pulping was carried out in 1.0 cu. ft. stainless steel digester, equipped with forced circulation and external heating. After the digester was charged with chips, liquor at 80°C. was transferred from the storage tank to the digester. The majority of the cooks were made with a liquor penetration technique. This was accomplished by applying a hydrostatic head of 80 p.s.i.g. to the digester contents through the liquor system. Pressure was maintained for 2 min., then quickly relieved to zero for 1 min. This cycle, repeated four times, displaced enough of the air in the chips with liquor so that the digestion could be brought up to top temperature (160°C.) in 2 hr. This technique was not used, in the case of mixed oak, or for the cooks made with aspen for the thiosulphate study and the comparison of high free sulphur dioxide, high combined sulphur dioxide and two-stage pulps.

The mixed oak charge was heated from 80 to 120°C. in 1 hr., held at 120°C. for $1^1/_2$ hr. and then brought up to top temperature (160°C.) in 1 hr., while the aspen was heated from 80 to 110°C. in $^3/_4$ hr., 110 to 120°C. in 1 $^1/_4$ hr. and from 120 to 160°C. (maximum temperature) in 1 hr.

Immediately after pressure impregnation, liquor was relieved from the digester to adjust the dilution ration to 4.5 l. of liquor to 1.0 kg. of moisture-free wood. This dilution ratio was also used for the normal liquor penetration cooks. Upon reaching top temperature (160°C.), the dilution ratio was again adjusted; this time to 3.5 l. of liquor to 1.0 kg. of moisture-free wood. Maximum pressure at top temperature was controlled at 80 p.s.i.g.

Sodium carbonate solution at about 120 g.p.l. as Na_2O was used to neutralize the acid cook and develop the alkaline stage pH. The carbonate solution was warmed to 80°C. in a stainless steel steam jacketed tank before it was injected into the digester. Prior to injection, any "true free SO_2," in the digester was relieved to minimize the quantity of alkali required to accomplish the neutralization. Since the acids in the digester liberate a large amount of carbon dioxide from the sodium carbonate, the digester gas relief valve was opened during the injection period to maintain 80 p.s.i.g. pressure within the digester. Normally, about 15 min. were utilized for the alkali injection period, after which the cook was held at 160°C. for the remainder of the alkaline stage.

Upon completion of the alkaline cook, the digester pressure was quickly reduced to 40 p.s.i.g., and the contents blown into a stainless steel blow pit designed as a cyclone separator, with a false bottom connected to a steam aspirator. The pulp was washed with four changes of water with about 5 min. of stirring between each draining. After the final wash, the pulp was thickened in the blow pit with the steam aspirator. The washed pulp was screened on a Valley flat screen equipped with 0.014-in. slotted screen plates. The accepted stock was caught and dewatered in a stainless steel, wire bottom box, and then further dewatered in a laundry centrifuge to about 30% moisture-free consistency. The dewatered pulp was mechanically broken into small lumps, weighed, and the moisture content determined, from which the moisture-free yield was calculated. Standard TAPPI permanganate

Table IV. Multistage Bleach Data—Jack Pine

Cook no. →	1	2	3	4	6	7 (Kraft)
$KMnO_4$ number	14.9	16.5	19.6	22.1	24.1	21.2
1st stage, % Cl_2 consumed as Cl_2	2.5	3.9	5.8	8.4	12.6	7.2
2nd stage, % NaOH as NaOH	2.0	2.0	2.0	4.0	4.0	2.0
3rd stage, % Cl_2 consumed as $Ca(OCl)_2$	1.5	1.5	1.4	1.2	1.5	1.5
4th stage, % NaOH as NaOH	...	...	...	...	...	2.0
5th stage, % Cl_2 consumed as $Ca(OCl)_2$	...	...	...	...	...	1.5
Total % NaOH	2.0	2.0	2.0	4.0	4.0	4.0
Total % Cl_2	4.0	5.4	7.2	9.6	14.1	10.2
Brightness, % G.E.	86.8	86.1	86.9	86.4	86.0	86.0
Bleaching yield (based on unbleached pulp), %	95.9	92.3	90.7	89.3	88.4	92.0
Over-all bleached pulp yield (based on moisture-free wood), %	38.8	39.9	40.6	40.9	42.1	40.4

Table V. High Free SO_2, High Combined So_2, and Bisulphite-Soda Comparative Cooking Data—Aspen

Cook no.	Acid stage: Liquor pH	Acid stage: Time at max. temp., hr.	Alkaline stage: Liquor pH	Alkaline stage: Time at 160 C., hr.	Total cooking time, hr.	$KMnO_4$ no.	Pulp yield[a]: Accepts,[b] %	Pulp yield[a]: Rejects, %	Pulp yield[a]: Total, %
21	1.8	3.00[c]	...	...	8.00	15.4	52.9	2.2	55.1
22	3.7	4.25	...	...	7.25	12.8	54.8	0.3	55.1
23	3.7	2.50[d]	8.5	1.5	7.00	15.9	53.2	0.5	53.7

[a] Calculated on moisture-free wood basis.
[b] Accepts through 0.014-in. screen plate.
[c] Maximum temperature 140°C.
[d] Maximum temperature 160°C.
Note: Cook no. 21, Conventional Na base high free SO_2 cook. Cook no. 22, High combined SO_2 Na base cook. Cook no. 23, Two-stage bisulphite-soda Na base cook.

numbers (25 cc. method) were run on all unbleached pulps.

A conventional three-stage bleaching sequence, consisting of (1) chlorination with chlorine water, (2) alkaline extraction with sodium hydroxide, and (3) hypochlorite treatment with calcium hypochlorite, was utilized to bleach all the two-stage pulps. Beaker scale (30 g. moisture-free pulp) bleaches were made on each pulp to determine the chlorine required to produce the desired brightness. The chlorine applied as hypochlorite in the third stage was held constant at about 1.3 to 1.5% based on the moisture-free pulp. In order to measure the bleaching yield, and prepare sufficient bleached pulp for beater testing, larger bleaches with 600 g. of stock were made, based on the information obtained from the beaker bleaches.

Bleaching conditions held constant were as follows: first stage—chlorination, 1 hr. at 2% consistency, 22 to 25°C., 1.4 to 2.6 pH, in a polyethylene container with agitation, with essentially complete consumption of the applied chlorine. Second stage—alkaline extraction. 1 hr. with 2% NaOH at 8% consistency, 40°C., 10.5 to 11.5 pH. Third stage—calcium hypochlorite applied at 1.3 to 1.5% available chlorine, 8% consistency, 40°C., and buffered with sodium hydroxide to produce a final pH in the range of 8.5 to 9.0. The hypochlorite treatment was permitted to run until the chlorine was nearly exhausted, which was about 3 hr. A glazed ceramic tank equipped with a high density agitator was used for the alkaline extraction and hypochlorite stages. This unit was submerged in an oil bath containing steam coils for temperature control. The stock was washed with three changes of water between stages and with four changes of water after hypochlorite. The bleached stock was dewatered with the steam aspirator and the laundry centrifuge. The dewatered stock pad was mechanically broken up and sampled for moisture.

The Palmrose method was utilized to measure the conventional total, free, and combined sulphur dioxide. Liquors containing sodium thiosulphate were analyzed by a modification of this method. Briefly, the procedure involved an additional titration of a liquor sample in which the bisulphite had been tied up with formaldehyde. Iodine liberated from potassium iodide by the thiosulphate was titrated with potassium iodate. The conventional Palmrose test was then corrected for thiosulphate by subtracting the sulphur dioxide equivalent of the thiosulfate from the total sulphur dioxide and adding this equivalent to the free sulphur dioxide.

Conventional high free sulphur dioxide single-stage cooks were made with 6.0 l. of liquor per kilogram of moisture-free wood following a time-temperature schedule as follows: 80 to 110°C. in $1^1/_2$ hr., 110 to 115°C. in 1 hr., 115 to 140°C. in $2^1/_2$ hr. and at 140°C. for 3 hr. Pressure was controlled at 80 p.s.i.g. by relief.

In order to avoid some of the shortcomings of the permanganate number, modified Tingle numbers (*1*) were determined for the pulps in the thiosulphate series. Accelerated brightness reversion was reported as P.C. (post color) number (*2*) which was calculated from the pulp G.E. brightness before and after revision in a forced air oven at 105°C. for 1 hr.

All beater testing was done in a 1.5-lb. Valley laboratory beater according to TAPPI Standard T 200 m-45 with 4500 g. on the bedplate for hardwoods and 5500 g. for jack pine. Handsheets were formed in accordance with T 205 m-53 and tested as specified in T 220 m-53.

Table VI. $Na_2S_2S_3$ in Soluble Base Sulphite—Comparative Cooking Data—Aspen

Cook no.	Acid stage: Liquor pH	Acid stage: Time at max. temp., hr.[a]	Acid stage: Per cent of Na as $Na_2S_2O_3$	Acid stage: $Na_2S_2O_3$ on oven-dry wood, %	Alkaline stage	Total Cooking time, hr.	$KMnO_4$ no.	Modified no., % Cl_2	Brightness, % G.E.	Pulp yield[b]: Accepts,[c] %	Pulp yield[b]: Rejects, %	Pulp yield[b]: Total, %
					High Free SO_2							
24	1.8	3.00	0	0	...	8.00	8.0	2.09	55.7	52.8	0.1	52.9
25	2.1	3.00	15.9	3.84	...	8.00	22.8	7.66	36.6	53.1	4.3	57.4
					High Combined SO_2							
26	3.6	3.75	0	0	...	6.75	17.5	4.56	44.4	54.9	0.5	55.4
27	<3.9/3.7>	3.75	7.2	1.59	...	6.75	15.3	3.83	47.1	53.0	0.4	53.4
28	<3.6/3.3>	3.75	16.6	4.00	...	6.75	19.8	6.32	44.4	54.5	1.4	55.9
					Two-Stage							
29	3.8	2.50	0	0	<[d]>	7.00	16.6	4.87	60.5	53.0	0.9	53.9
30	3.6	2.50	10.3	2.12	<[d]>	7.00	11.6	3.89	66.0	52.4	0.4	53.8
31	<3.7/3.4>	2.50	29.3	7.75	<[d]>	7.00	15.9	4.54	48.9	51.5	1.2	52.7

[a] High free SO_2 cooks—maximum temperature 140°C. High combined SO_2 and two-stage cooks—maximum temperature 160°C.
[b] Calculated on moisture-free basis.
[c] Accepts through 0.014-in. screen plate.
[d] Alkaline stage—$1^1/_2$ hr. at 160°C.—pH 8.5.

Table VII. Multistage Bleach Data—Effect of Thiosulphate—Aspen

Cook no. →	High free SO_2 <24>	High free SO_2 <25>	High combined SO_2 <26>	High combined SO_2 <28>	Two-stage <29>	Two-stage <31>
$Na_2S_2O_3$, %, on oven-dry wood	0	3.84	0	4.00	0	7.75
$KMnO_4$ number	8.0	22.8	17.5	19.8	16.6	15.9
Modified tingle number, % Cl_2	2.09	7.66	4.56	6.32	4.87	4.54
1st stage, % Cl_2 consumed as Cl_2	1.0	7.3	2.9	4.3	2.5	2.1
2nd stage, % NaOH as NaOH	2.0	2.0	2.0	2.0	2.0	2.0
3rd stage, % Cl_2 consumed as $Ca(OCl)_2$	1.5	1.5	1.5	1.5	1.5	1.5
Total Cl_2, %	2.5	8.8	4.4	5.8	4.0	3.6
Brightness, % G.E.	86.3	86.1	85.7	86.0	85.8	86.5
P.C. number	0.85	0.96	0.70	0.77	0.62	0.49
Bleaching yield (based on unbleached pulp), %	95.0	88.3	93.5	93.6	94.1	95.0
Over-all bleached pulp yield (based on oven-dry wood), %	50.2	46.8	51.3	51.0	49.9	48.3

The pulp brightness was determined on handsheets prepared with distilled water. Opacity is reported as contrast ratio (C/R) T 425 m-44.

Presentation and Discussion of Results

Hardwoods. The aspen pulping data summarized in Table I, indicate the variation in permanganate number and yield that can be accomplished by manipulation of the alkaline stage pH and cooking time. When the second stage pH is greater than 9.0, a sharp drop in yield occurs unless the time is shortened. Alkaline hydrolysis of the partially depolymerized hemicellulose and less resistant cellulose material takes place and alpha cellulose increases. Approximately 16.0% Na_2O based on the moisture-free wood is required for an aspen cook such as cook no. 9. About 7.5% Na_2O is used for the acid stage and about 8.5% Na_2O for the alkaline stage to produce 8.5 pH. To get a second stage pH of 10.7, as in cook no. 8, requires 15.0% Na_2O in the second stage.

In the case of aspen, the strongest unbleached pulps were prepared with a relatively mild alkaline stage, that is, pH about 8.0. This is illustrated in Figs. 5 and 6 by cooks nos. 10 and 11; cook no. 11, having a lower pH, but slightly less alkaline time, has better bursting and tearing strength than cook no. 10.

Since aspen is a very low lignin content wood, only about 2 hr. at 160°C. during the acid stage were required to produce pulps in the 12 to 14 $KMnO_4$ number range, while the denser hardwoods such as oak, required at least 3 hr. under similar conditions to produce pulps in the same $KMnO_4$ number range.

Two-stage oak pulping data are tabulated in Table I, cooks nos. 12 to 15. A kraft oak cook (no. 16) is included with this species for comparison. It appeared that the oak alkaline two-stage pulping produced pulps with desirable characteristics when the alkaline stage pH was about 9.0 to 9.5. If the alkaline stage pH was below 8.5 the resulting pulp had the characteristics of neutral sulphite pulp; however, when the pH was 9.0 to 9.5 or greater, the two-stage pulp was produced with the desirable characteristics of high strength accompanied by high bulk. A screened pulp yield of approximately 40% was obtained from mixed oak when pulped by the two-stage process. This is about 2 to 4% less than can be obtained by a kraft cook, but this difference is reduced when the pulps are bleached to the same brightness.

Figures 5 and 6 indicate the two-stage oak pulp strength as similar to kraft oak pulp.

Birch, soft maple, hard maple, and elm were cooked much like oak, both in the acid stage and the alkaline stage. About 18% Na_2O is required to pulp oak, while slightly less is required for the above hardwoods. Cooking times are similar if comparable techniques are used. The mixed oak series reported in Table I indicates a longer total time was required for oak than the other hardwoods, but less time at 160°C. during the acid stage. In these oak cooks no rapid penetration was used. Therefore, the time to top temperature was longer. The unbleached strength properties of both hard and soft maple were found to be slightly poorer than oak, but the pulps were light colored, easy bleaching, and bulky. Excellent physical strength

Table VIII. Handsheet Strength Data at Constant Bulk (Unbleached Pulp) Pulps Made with $Na_2S_2O_3$ in Cooking Liquor

Cook no.	$Na_2S_2O_3$ on O. D. wood, %	Bulk, cc./g.—1.5: Tensile strength, lb./in. width	Folding endurance, M.I.T. double folds	Bursting strength, % Mullen	Tearing resistance, % tear	Bulk, cc./g.—1.2: Tensile strength, lb./in. width	Folding endurance, M.I.T. double folds	Bursting strength, % Mullen	Tearing resistance, % tear
				High Free SO_2					
24	0	17.5	2	33	63	24.4	70	74	58
25	3.84	17.1	2	31	47	26.2	70	72	58
				High Combined SO_2					
26	0	22.6	17	61	67	32.0	198	96	64
27	1.59	22.0	50	59	78	31.6	255	96	73
28	4.00	25.3	28	67	75	33.9	353	107	64
				Two-Stage					
29	0	26.1	77	81	98	38.8	1000	134	76
30	2.12	24.6	51	71	95	34.8	745	120	94
31	7.75	25.2	108	83	100	37.9	705	126	90

Note: Pulps processed in Valley beater—4500 g. on bed plate.

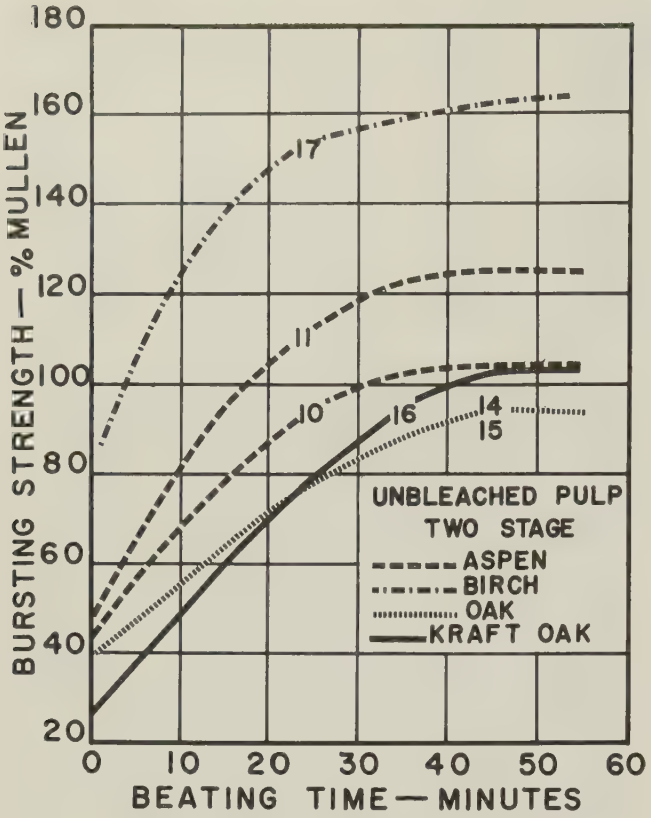

Fig. 5. Bursting strength development of some unbleached hardwood pulps

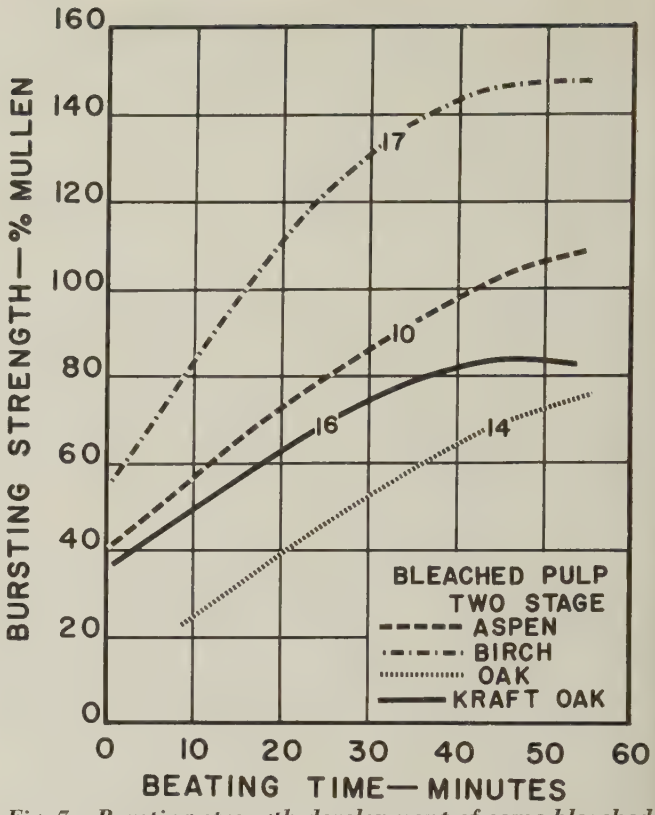

Fig. 7. Bursting strength development of some bleached hardwood pulps

was developed in two-stage birch pulp. Bursting strength, shown in Fig. 5, was equal to that which can be developed in birch kraft. The two-stage birch tearing resistance as indicated in Fig. 6 is slightly lower than usually realized from this species when pulped by the kraft process. However, laboratory two-stage birch pulps have been prepared with tearing resistance equal to birch kraft pulp, and also with more bulk than the kraft pulp.

A summary of bleaching data and results on the hardwood species can be found in Table II. The two-stage pulps were easily bleached to 88% G.E.

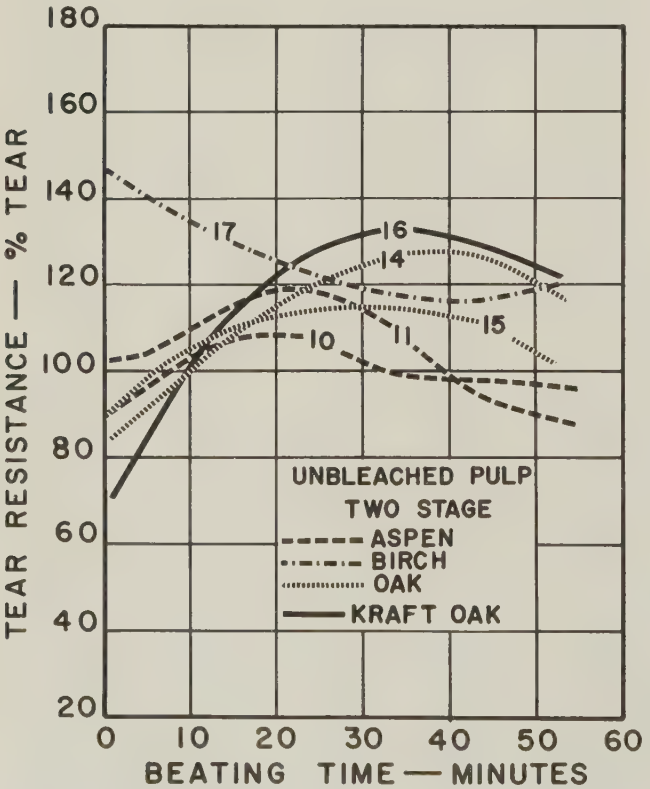

Fig. 6. Tearing resistance of some unbleached hardwood pulps

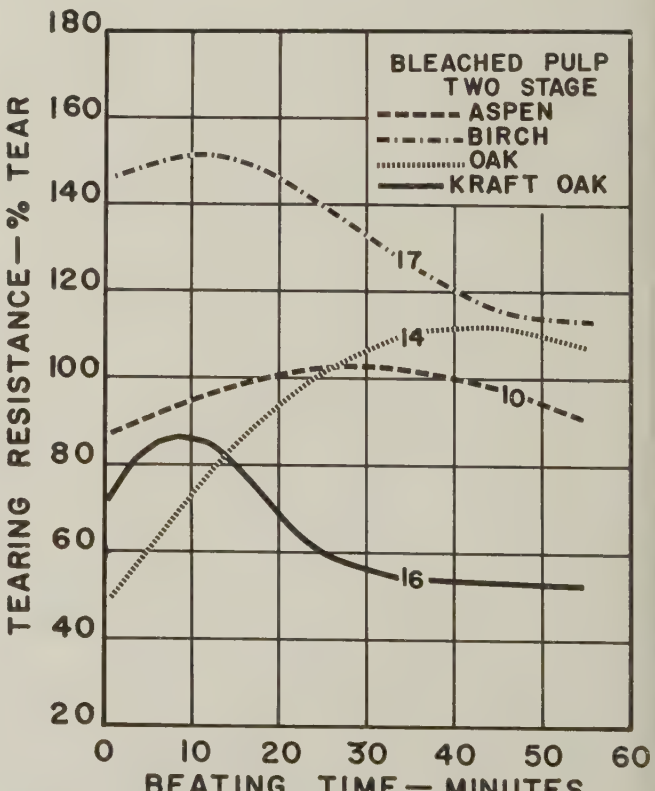

Fig. 8. Tearing resistance of some bleached hardwood pulps

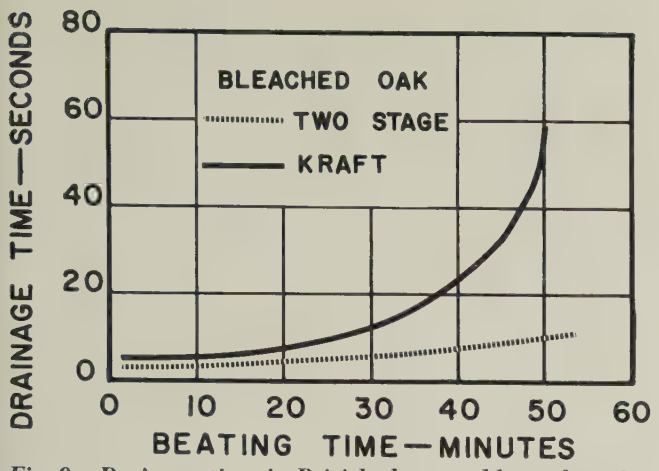

Fig. 9. Drainage time in British sheet mold as a function of beating time

brightness in three stages with no loss of strength and very little accelerated brightness reversion. Cook no. 14, a two-stage mixed oak pulp having a $KMnO_4$ number of 13.2, required 3.8% total chlorine to bleach to 88.6% G.E. brightness, while the kraft mixed oak, $KMnO_4$ number 13.0, cook no. 16, required 6.7% Cl_2 to produce a 85.2% G.E. brightness in five stages.

Bursting strength and tearing resistance of the bleached hardwoods are shown in Figs. 7 and 8. As indicated in these figures, bleached two-stage oak pulp has a slightly lower maximum burst than bleached kraft pulp, but the two-stage pulp is very much better in tearing resistance than the kraft pulp. The two-stage bleached aspen, birch, and maple pulps develop about the same strength as the unbleached pulp.

Because of the striking difference in the drainage behavior of two-stage pulps and kraft pulps, the drainage time in a British sheet mold has been plotted for bleached two-stage and kraft oak in Fig. 9. The flat curve for the two-stage pulp, showing very little increase in slowness with beating classifies the pulp as hard beating, and indicates that strength and formation can be developed without excessive hydration. Also of significance is the relationships between pulp opacity (C/R) and degree of beating. This is shown in Fig. 10.

Jack Pine. A summary of pulping data and results from two-stage cooks made with jack pine are given in Table III. This series includes pulps in a $KMnO_4$ number range of 14.9 to 24.1, with total unbleached moisture free yields of 41.0 to 53.9%. Figures 11 and

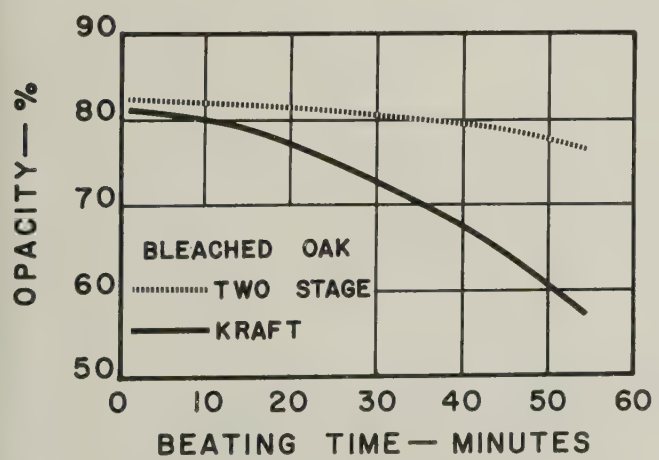

Fig. 10. Handsheet opacity (contrast ratio) as a function of beating time

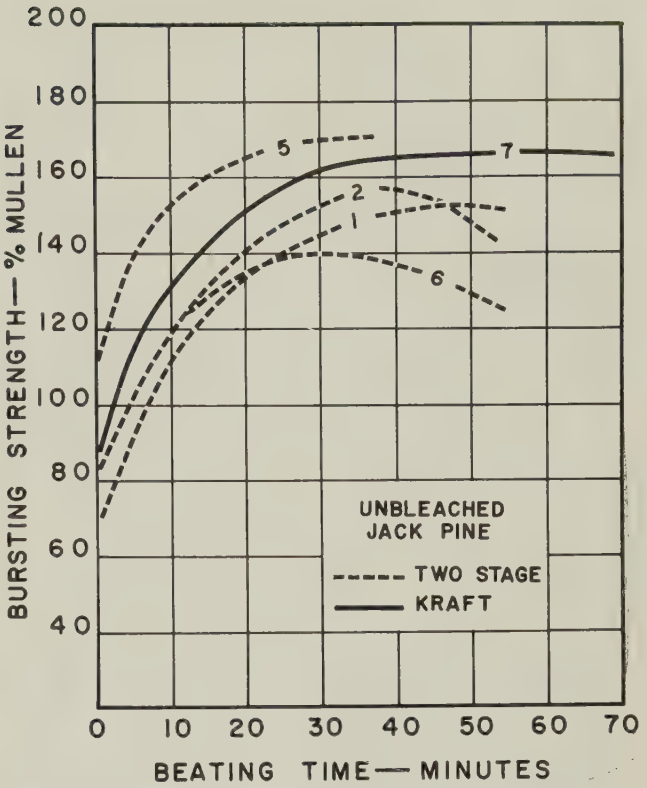

Fig. 11. Bursting strength development of unbleached jack pine pulp

12 show the burst and tear development of these pulps compared to a kraft pulp made from the same lot of wood. It is possible to make a wide range of pulp types as indicated by these curves. Pulp no. 5 has a

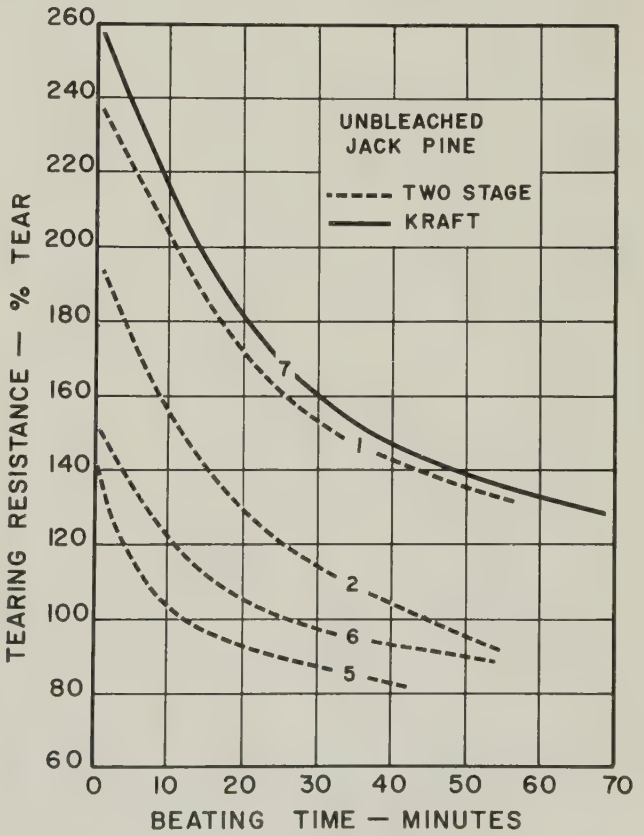

Fig. 12. Tearing resistance development of unbleached jack pine pulp

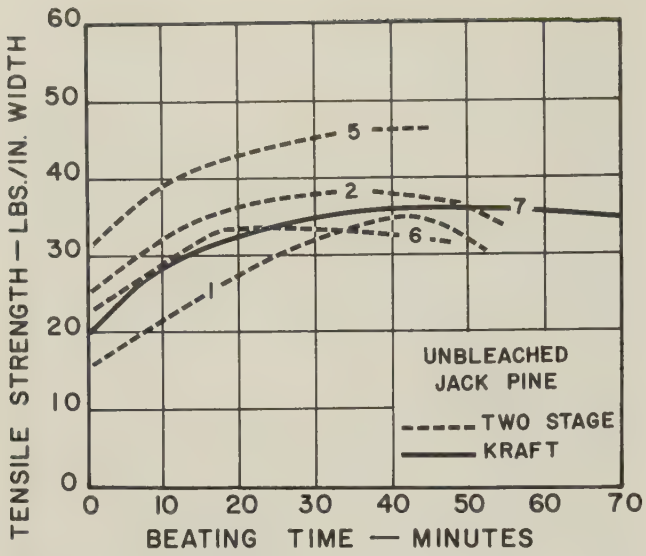

Fig. 13. Tensile development of unbleached jack pine pulp

maximum burst well above the kraft pulp, but the tear is comparatively low. This was caused by using a mild alkaline treatment, which in this case was only 1 hr. at 7.6 pH. On the other hand, pulp no. 1 is slightly lower in bursting strength than the kraft pulp, but the tear is practically identical with the kraft pulp. Tensile strength will also vary considerably, depending on the pulp type. This is shown in Fig. 13.

Jack pine is most effectively cooked two-stage with a relatively high first stage pH, especially during the early part of this stage. It was established that uniformly cooked jack pine pulps could be made with a starting pH of 4.0 to 4.5 that would fall to about 3.5 to 3.7 pH at the end of the first stage. Unbleached

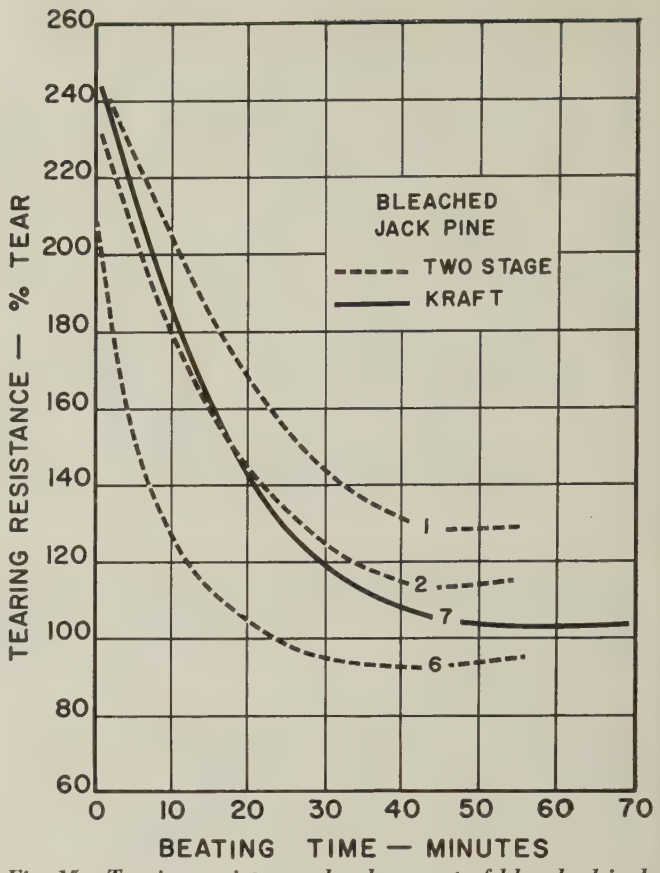

Fig. 15. Tearing resistance development of bleached jack pine pulp

two-stage jack pine pulps that have been prepared with alkaline stages of pH 9.0 or greater have approximately the same amount of ether-soluble and total pitch (T 204 m-54) as jack pine kraft.

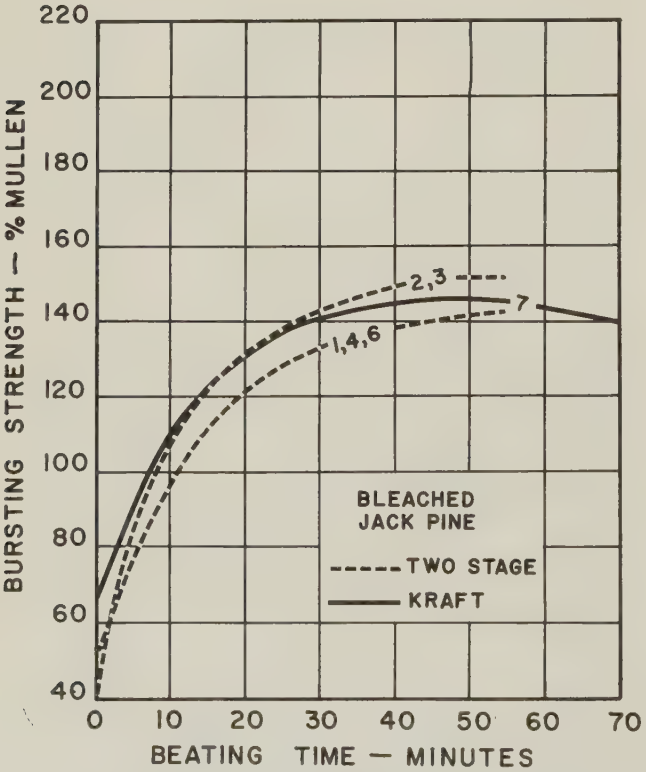

Fig. 14. Bursting strength development of bleached jack pine pulp

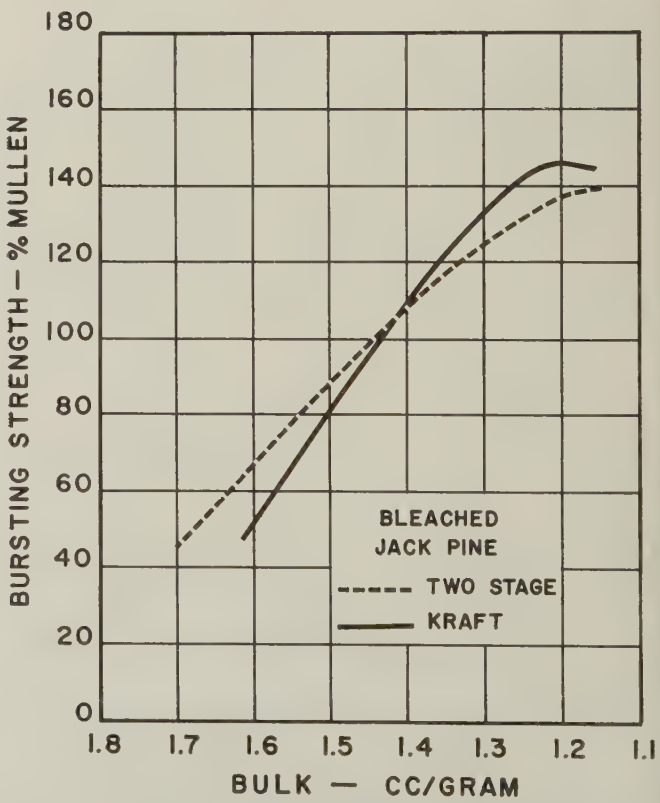

Fig. 16. Relationship between jack pine bursting strength and bulk

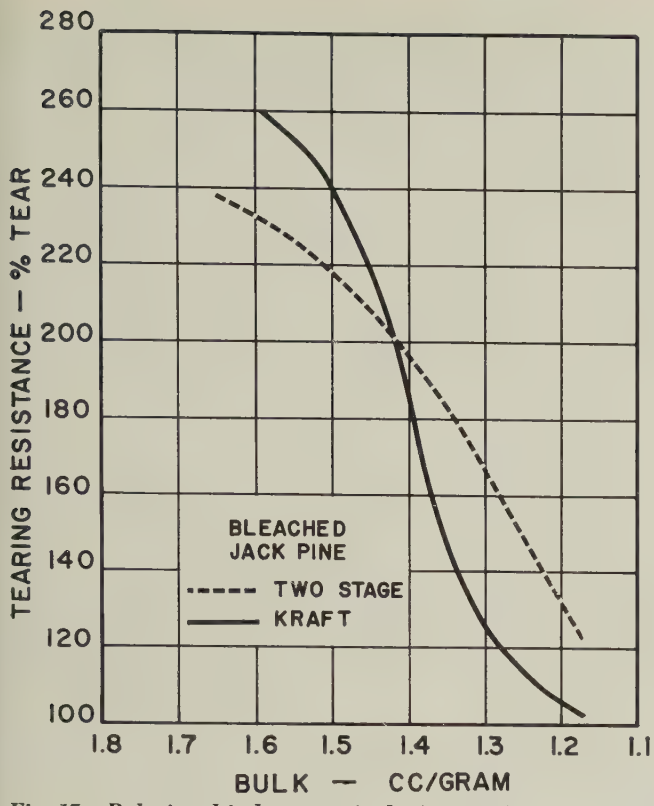

Fig. 17. Relationship between jack pine tearing resistance and bulk

Two-stage jack pine pulp was easily bleached to high brightness in three steps, and as indicated in Table IV, the yield of moisture-free bleached pulp based on the moisture-free wood is similar to kraft.

As shown in Figs. 14 and 15, there is little difference between the bursting strength and tearing resistance of the two-stage and kraft pulps. When these two physical test values are plotted against the bulk, as in Figs. 16 and 17, the similarity of strength properties between two-stage and kraft is more apparent. In this case all the bleached two-stage pulps fall on a common curve.

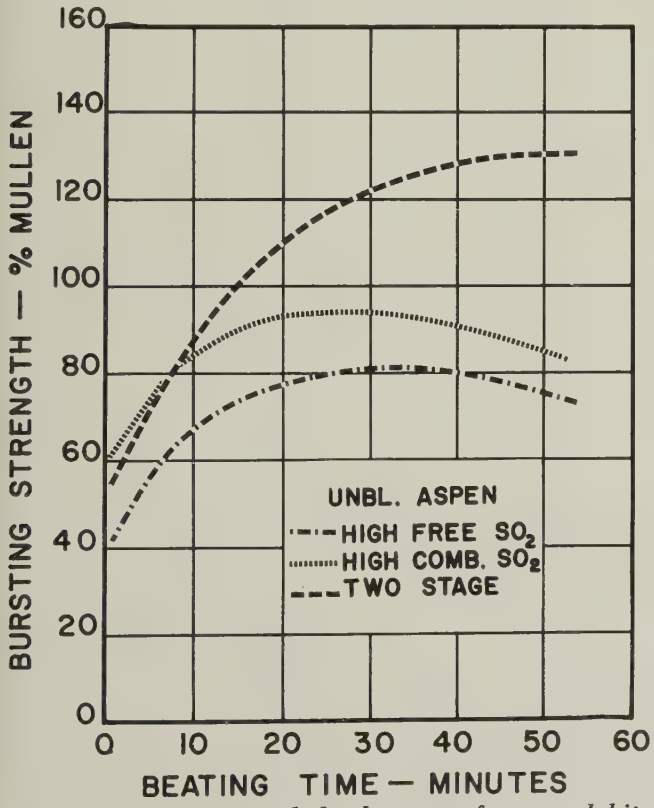

Fig. 18. Bursting strength development of aspen sulphite pulps and aspen two-stage pulps

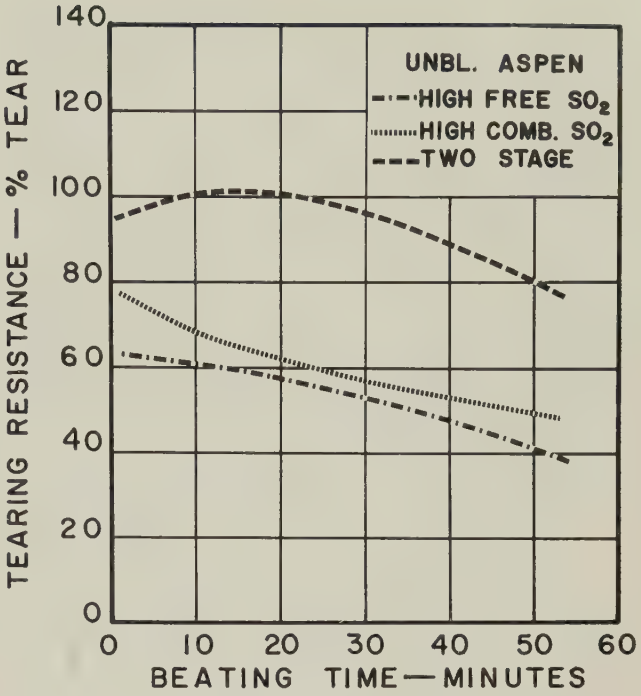

Fig. 19. Tearing resistance development of aspen sulphite pulps and aspen two-stage pulps

Comparison of Two-Stage with Sulphite. The work with jack pine and mixed oak has served to compare two-stage pulp properties with those of kraft pulp. To complete the picture, two-stage pulps should be compared with conventional high free sulphur dioxide and high combined sulphur dioxide single-stage sulphite pulps. A study with aspen was carried out to investigate and compare these pulping methods. Pulping conditions and results from a representative cook of

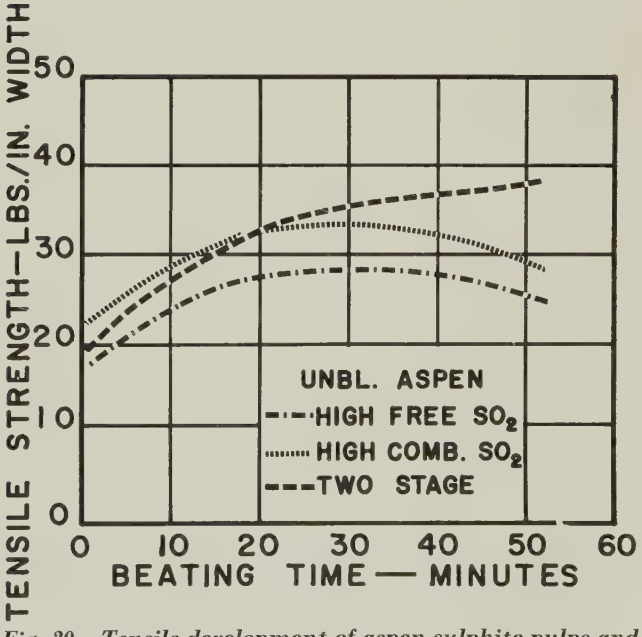

Fig. 20. Tensile development of aspen sulphite pulps and aspen two-stage pulps

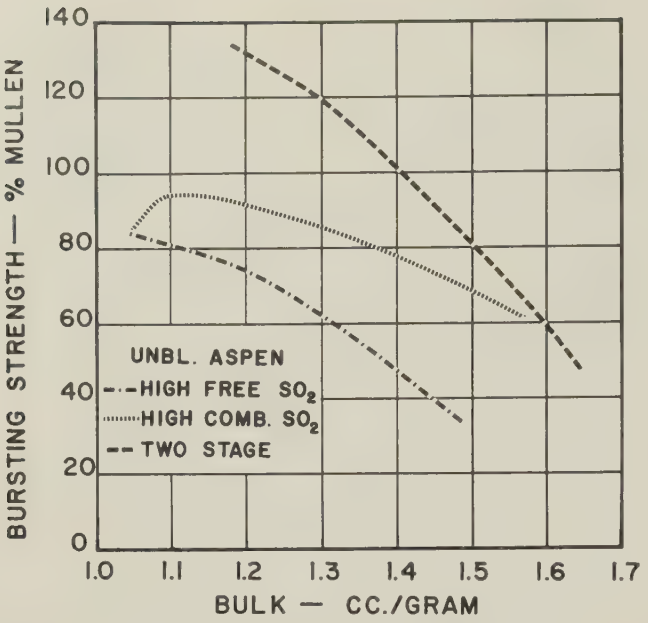

Fig. 21. Comparison of bursting strength of aspen sulphite and aspen two-stage pulps at similar values of bulk

each type are tabulated in Table V. These pulps have all been prepared at approximately the same $KMnO_4$ number. Total cooking time was 8 hr. for the high free sulphur dioxide cook at 140°C. as compared to 7.25 hr. for the high combined sulphur dioxide cook and 7.00 hr. for the two-stage cook, both at 160°C. (no rapid penetration used). The two-stage cook had the highest unbleached pulp brightness (60.5% G.E.) while the high combined and the high free cooked pulps were considerably lower with 45.2 and 44.4% G.E. brightness, respectively. The bursting strength, tearing resistance, and tensile strength, for these unbleached pulps have been plotted against beating time in Figs. 18, 19, and 20. The two-stage (cook no. 23) developed the greatest bursting strength—130% burst compared to about 95% for the high combined sulphur dioxide pulp and 80% for the high free sulphur dioxide pulp. Tearing resistance was about equal for the single-stage pulps, both high free and combined sulphur dioxide, but was considerably greater for two-stage pulp. Tensile curves, as expected, were similar to bursting strength curves. Although it is not shown, folding endurance was much better for the two-stage pulp than either of the single-stage pulps. The bursting strength and tearing resistance of the three unbleached pulps have been plotted against bulk in Figs. 21 and 22. These curves indicate the superior strength

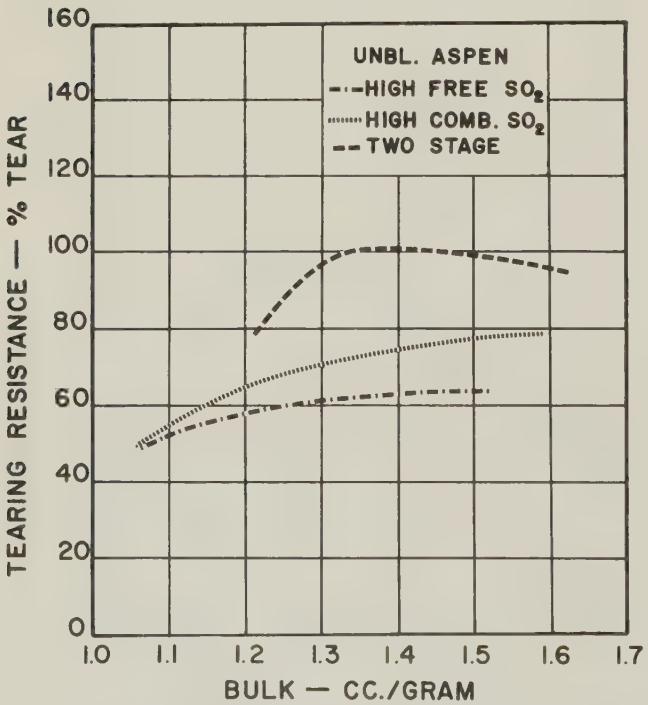

Fig. 22. Comparison of tearing resistance of aspen sulphite and aspen two-stage pulps at similar values of bulk

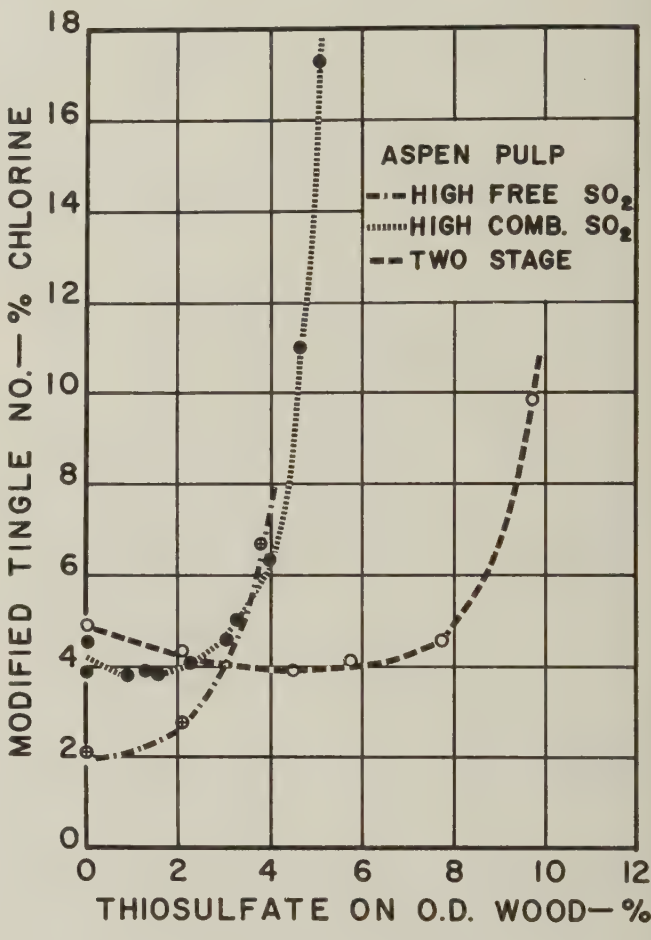

Fig. 23. Chlorine demand of unbleached pulp as a function of $Na_2S_2O_3$ in the cooking liquor

properties of two-stage pulp when the comparison is made at equal bulk.

All three pulp types were easily bleached to high brightness in three stages. In the case of the high free sulphur dioxide pulp 5.7% Cl_2 was required to bleach to 86% G.E. brightness, while the high combined sulphur dioxide pulp required 3.9% Cl_2 and the two-stage pulp 3.7% Cl_2 to reach this brightness. There was very little difference in the over-all yield of bleached pulp based on the moisture-free wood between the three pulp types. Accelerated brightness reversion was most pronounced in the case of the high free sulphur dioxide pulp (P.C. number of 0.85). The high combined sulphur dioxide (P.C. number of 0.70) and two-stage (P.C. number of 0.62) pulps exhibited slightly less accelerated reversion.

Effect of Thiosulphate in Soluble-Base Sulphite Pulping. Aspen was chosen as the single species for investigation, since it is relatively easy to pulp and normally yields a light colored unbleached stock. This project was designed to show the effect of sodium

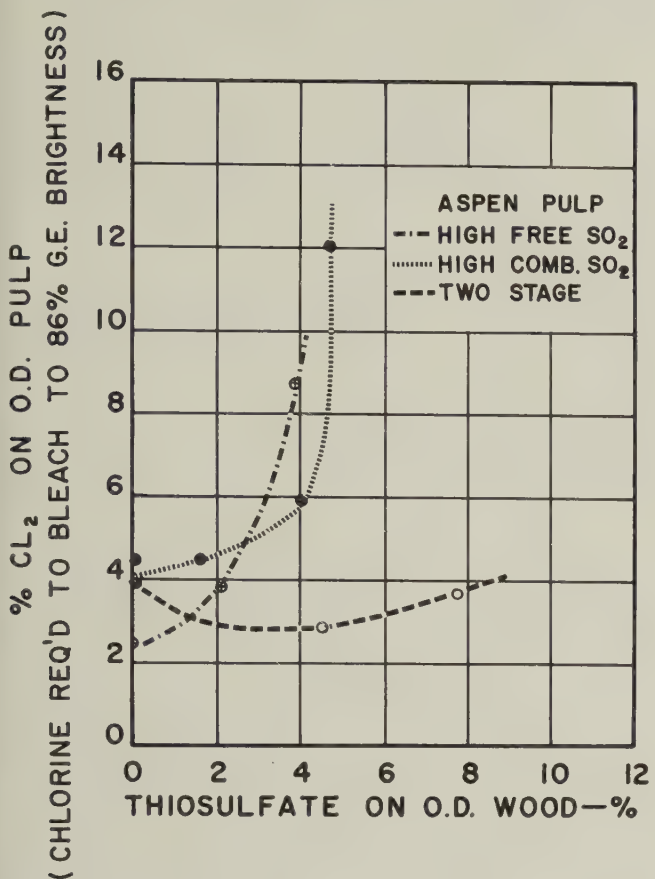

Fig. 24. Chlorine required to bleach pulp to 86% G.E. brightness

thiosulphate, over a wide range of concentration, in three basic types of sodium-base sulphite pulping processes: (1) Conventional high free sulphur dioxide, (2) high combined sulphur dioxide, and (3) two-stage bisulphite-soda. Pulping data and results have been summarized for a few cooks in each series in Table VI.

Sodium thiosulphate is readily soluble in sodium-base sulphite cooking acids, forming a stable, colorless solution. The initial observation of deviation from a conventional sodium-base sulphite cook is in the liquor color and appearance. At some point after maximum temperature has been attained, a rapid and sharp change in liquor color and appearance occurs. The liquor becomes very dark and muddy and it is impossible to detect sulphur dioxide with the Palmrose test or thiosulphate with the method described in the experimental section. The pH begins to drop and cannot be controlled by gas relief. The greater the amount of sodium thiosulphate based on moisture-free wood, the earlier in the cook this phenomenon takes place.

Table X. Summary of Three Mill Scale Trial Cooks

Cook no.	*1*	*2*	*3*
Moisture free wood charged, lb.	251,900	261,900	274,900
Liquor to wood ratio, 1st Stage, lb./lb.	3.9/1.0	4.0/1.0	4.2/1.0
SO_2 applied, [a] %	16.9	17.1	17.5
Na_2O applied first stage, [a] %	7.8	8.1	8.3
Na_2O applied second stage, [a] %	8.2	8.2	8.2
Second-stage pH	8.7	8.2	8.5
Total cooking time, hr.	8.0	8.0	8.0
$KMnO_4$ number of unbleached pulp	20.8	17.7	16.4
Screening reject yield, [a] %	6.0	5.0	3.5
Average Cl_2 for chlorination, [b] %		3.5	
Average NaOH for extraction, [b] %		1.0	
Average Cl_2 for hypochlorite, [b] %		2.8	
Average bleached pulp brightness, % G.E.		85.9	
Average P.C. number		1.4	

[a] Based on moisture-free wood.
[b] Based on moisture-free unbleached pulp.

When the modified Tingle number (per cent chlorine) is plotted against per cent thiosulphate based on moisture-free wood weight, an excellent picture showing the effects of thiosulphate on pulp bleachability is obtained. This has been done in Fig. 23. If the permanganate number is substituted for the Tingle number a similar set of curves is produced, but the modified Tingle number is a more sensitive test for bleach demand and is not subject to many of the complications inherent in the determination of permanganate number. Attempts found in the literature to correlate thiosulphate concentration with effects produced have largely been on the basis of reporting thiosulphate concentration in the liquor. Per cent of the sodium as sodium thiosulphate or per cent of the sulphur as

Table IX. Handsheet Strength Data at Constant Bulk (Bleached Pulp) Pulps Made with $Na_2S_2O_3$ in Cooking Liquor

Cook no.	*$Na_2S_2O_3$ on oven-dry wood, %*	*Bulk, cc./g.—1.5*				*Bulk, cc./g.—1.2*			
		Tensile strength, lb./in. width	*Folding endurance, M.I.T. double folds*	*Bursting strength, % Mullen*	*Tearing resistance, % tear*	*Tensile strength, lb./in. width*	*Folding endurance, M.I.T. double folds*	*Bursting strength, % Mullen*	*Tearing resistance % tear*
				High Free SO_2					
24	0	13.2	16	38	49	21.5	60	70	56
25	3.84	11.7	4	31	55	25.4	143	90	56
				High Combined SO_2					
26	0	15.0	14	51	82	27.3	439	98	67
28	4.00	15.8	18	50	72	30.5	314	104	69
				Two-Stage					
29	0	16.3	15	58	90	32.0	1165	124	85
31	7.75	16.0	23	54	89	32.1	618	116	98

Note: Pulps processed in Valley beater—4500 g. on bed plate.

sodium thiosulphate have been used. However, in this work it was found that much better correlation of the thiosulphate effect with quantity present was possible when the thiosulphate concentration was based on the wood weight.

The conventional high free sulphur dioxide type of cook is extremely sensitive to thiosulphate. The results obtained from the high combined sulphur dioxide cooks are slightly different. As the thiosulphate concentration was increased to about 2%, the bleachability decreased. Increasing the concentration above 2% causes the bleachability to increase until at about 2.5% thiosulphate the modified Tingle number is about that for a pulp made without thiosulphate. It is obvious from Fig. 23 that pulp can be made by the two-stage process with relatively large amounts of thiosulphate present in the cooking liquor, and with no detrimental effects on bleachability. As the thiosulphate concentration was increased to about 5%, the bleachability was decreased. Approximately 8% of thiosulphate is required to increase the modified Tingle number to equal that of the base cook (no thiosulphate). Thiosulphates effect the unbleached pulp brightness in much the same manner as they do the modified Tingle number. When the modified Tingle number decreases with increasing thiosulphate concentration, brightness increases. At the point where the modified Tingle number begins to increase sharply, the brightness rapidly decreases. If the total unbleached pulp yield were plotted against thiosulphate concentrations, curves similar to those in Fig. 23 would result. Effect of thiosulphate on yield is not as pronounced as on bleachability and unbleached brightness, but can be definitely recognized.

Although the modified Tingle number is an index of pulp chlorine demand in bleaching, it does not indicate whether any given brightness can be attained. Interpolated values of per cent chlorine to bleach to 86% G.E. brightness have been plotted against the thiosulphate concentration (based on the moisture-free wood) in Fig. 24. No difficulty was experienced in bleaching any of the pulps to this brightness. The pulps with the higher bleach demand simply required more chlorine. It can be seen that these curves are identical to the curves of Fig. 19. A bleaching summary is presented in Table VII.

Pulps made with thiosulphate yield less over-all bleached pulp per weight of wood than do the base pulps (no thiosulphate). This is particularly noticeable in the case of the single-stage high free sulphur dioxide cooks. In the case of the high free sulphur dioxide and high combined sulphur dioxide type cooks, the accelerated brightness reversion (P.C. number) is poorer for the pulps made with thiosulphate than for pulps made without. The opposite is true for the two-stage pulps where the pulp made with 7.75% thiosulphate (cook no. 31) has a lower P.C. value than the pulp made without thiosulphate (cook no. 29).

A comparison between the physical strengths of the unbleached pulps made with and without thiosulphate is presented in Table VIII. Here the strength properties have been interpolated and presented at two values of bulk, 1.5 and 1.2 cc. per g. These data indicate very little change in strength with increasing amounts of thiosulphate. In other words, there is little strength damage done to the pulp within the limits of thiosulphate which will still produce a pulp. In Table IX the strength properties are again presented, only this time for the bleached pulps, but at the same interpolated values of bulk. Again, there is no significant reduction in strength with pulps made with thiosulphate in the acid cooking liquor.

Commercial Scale Cooks

In order to project the experience gained from the quite thorough survey of the bisulphite-soda pulping process using only pilot plant scale pulping and bleaching equipment, it was decided to make some cooks in one of the mill sulphite digesters. If successful, these cooks would provide larger amounts of pulps for study and furnish opportunities to obtain data regarding blow pit washing and collection of spent liquor. A total of six cooks were made, two single cooks to gain experience, and a series of four consecutive cooks. It was possible to make these cooks with a minimum of interference with the regular operation of the three other digesters that were on conventional calcium-base acid sulphite production.

The digester chosen was a 6300 cu. ft. vessel that was equipped with a strainer and outside liquor circulating system, but was steamed direct. The preparation of the sodium bisulphite cooking liquor was readily improvised because it was not necessary to build up a concentration of free sulphur dioxide over the bisulphite point.

A caustic solution of proper concentration was prepared in a wooden raw acid storage tank. Purchased liquid sulphur dioxide was introduced directly from the tank car until the desired sodium bisulphite concentration was obtained.

The wood used for all of the large cooks was peeled, seasoned mixed species oaks. Careful scaling of the wood into the wood room with knowledge of the density provided the weight of wood in the digester. The digester was filled in each case to the strainer level which left about 10 ft. of free headroom. This allowed the cook to be handled somewhat easier with respect to condensate accumulation and relief, the facilities for which were known to be not ideal for this type of cook. Sufficient cold cooking liquor was pumped in to cover the chips.

The digester was steamed direct to top temperature of 150 to 155°C. in $4^1/_2$ hr. The cook was held at top temperature for $1^1/_2$ hr. or until the liquor tests showed that the bisulphite stage was complete. The Palmrose test and the ultraviolet spectrophotometer lignin test (*3*) were used to determine this point.

Wet relief was taken off down to the starting 10-ft. head room and sent to the accumulator for use in the regular sulphite pulping.

To neutralize the first-stage cook and start the second stage, 50% caustic was pumped from a tank car into the intake side of the digester liquor circulating pump. This injection required about 20 min. and was controlled by pH measurements. The alkaline stage was continued for 2 hr. The end point for this stage was determined by use of a rapid $KMnO_4$ number taken on a sample of pulp blown from the sample line.

At the end of the second stage the digester was blown into its blow pit that had been padded with spent liquor

from the previous cook. Sufficient padding was used to level the pulp in the pit.

Spent liquor collection data showed that the digester strength at blow of the spent liquor was 18.5 to 19.0% total solids. The pits drained at a lower rate than for calcium-base poplar cooks with indications that 75% of the total solids could be collected in this manner to yield an evaporator feed having 15% total solids.

Essential information for three typical cooks and associated bleaching information is shown in Table X.

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Presented at the Twelfth Alkaline Pulping Conference of the Technical Association of the Pulp and Paper Industry, Hot Springs, Ark., Sept. 24–26, 1958.

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Much credit is due to George Saindon and George Fuhs, research pulping technicians, for carrying out of the experimental cooks, bleaches, and beater testing the numerous pulps prepared. Donald Surprison carried out physical evaluations of all woods used and prepared all woods in chip form for the experimental cooks.

Characterization of Unbleached Pulps by Their Bromine Consumption

THEODOR N. KLEINERT and JEAN M. ROBERGE

Bromination of unbleached pulps by means of an acidified *N*/10 potassium bromate-bromide solution was investigated. In particular, the influence of the acidity of the reaction mixture, the reaction temperature and reaction time was studied. For pulps derived from the same wood species and cooked under similar conditions, a straight-line relationship was found to exist between the values of the reaction time and the bromine consumption when plotted on a log-log scale. For spruce sulphite pulps produced under the same cooking conditions up to a yield of about 60% (calculated on wood) with variation of the cooking time, and for poplar sulphite pulps in an even higher yield range, a distinct linear relationship was found in both cases between the bromine consumption at constant reaction time (30 min.) on one hand, and the pulp methoxyl content and Roe chlorine number on the other. However, the numerical values of this relationship were found to vary when different wood species and/or different cooking conditions were used. A similar finding was made in regard to the pulp bromine consumption and the pulp lignin content determined according to TAPPI Standard T 222 m-50, indicating that no consistent relationship exists for general application. Whereas the bromine consumption of unbleached pulps can be considered to be related to the total of the lignin present, the Klason lignin represents the acid-insoluble lignin portions only. The determination of the bromine consumption of unbleached pulps is a valuable supplement to the Roe chlorine number determination, particularly in the case of low lignin pulps. A titrimetric bromination procedure is outlined.

Halogenation of unbleached pulps is extensively used either for the determination of the bleachability or for an indirect estimation of the residual lignin. This applies particularly to the Roe chlorine number determination and its modifications (*1–4*). A basic difficulty in all methods for the determination of lignin in pulp materials, is caused by the fact that lignin is not a well defined substance of constant composition (*5*), but rather is a mixture of related substances which contain both aromatic and aliphatic groups (*6–8*). In sulphite pulps the residual lignin is partially sulphonated (*9*), in kraft pulps it is present as thiolignin (*10*).

Bromination has been suggested as a means of estimating the residual lignin of unbleached pulps. According to the Tingle method (*11*), the pulp material is first hydrolyzed with strong sulphuric acid and the resulting acidic hydrolyzate is subjected to bromination by means of hypobromite solution. Kleinert and Sieber (*12*) investigated the bromination of pulp hydrolyzates produced in a mixture of phosphoric and hydrochloric acid, using *N*/10 potassium bromate-bromide solution as the brominating reagent. It was found that high-lignin pulps were incompletely hydrolyzed and also small amounts of bromine consuming products were formed by the hydrolysis of carbohydrates. For this reason an attempt was made to eliminate pulp hydrolysis and to achieve direct bromination of the pulp material.

The bromination of lignin in an acidic medium has been studied by several investigators (*13–16*). In general, it was found that partial substitution (*16–17*) and also a cleavage of side chains takes place (*18*). Recently, pulp bleaching with bromine was investigated (*19*). The use of elemental bromine in lignin determinations was suggested by Kuerschner, *et al.* (*20*). Bromine consumption was found to be dependent on the bromine concentration, the solvent, and the reaction time used. It is also known that the acidity of the reaction medium has some influence on the bromination reaction, and that additions of hydrochloric acid exhibit a catalytic effect (*21–23*). The powerful action of bromine in an aqueous, acidified solution (*24–25*) is attributed to the formation of the hydrated bromine cation (*26–28*), which exhibits a noticeable stability (*29*).

The authors of this paper investigated the bromination of unbleached pulps, and in particular studied several variables which have a bearing on the bromine

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consumption. The question arose whether pulp bromination could be used as an empirical measurement of the lignin content.

EXPERIMENTAL WORK

Pulp Material

Various unbleached pulps cooked to various yields, especially spruce bisulphite pulps, were subjected to bromination. In a preliminary study, it was found that pulp heterogeneity impaired the reproducibility of the bromine consumption in many cases, particularly when high yield pulps containing large amounts of fiber bundles and shives were investigated. To overcome this difficulty, the pulps were ground in a Wiley mill to particle sizes corresponding to 40 to 60 mesh, and the resulting powders were thoroughly mixed. In this way good reproducibility of the bromine consumption was obtained, even in the case of pulp materials of very high yield and of groundwood.

Acidity of the Reaction Mixture

In the investigations, acidified $N/10$ potassium bromate-bromide solution was used as brominating agent. The free bromine produced in the aqueous solution hydrolyses less than does chlorine. Below pH 5, practically all the bromine is present in the form of the bromine cation. Thus bromination of organic substances by substitution is promoted.

In a series of experiments, equivalent additions of hydrochloric acid and sulphuric acid were compared as acidifying agents in pulp bromination under the same conditions (Table I). The bromination of the pulp samples was carried out in stoppered glass flasks at 25 ± 0.1°C. for exactly 30 min. ±10 sec., the bottles being immersed in a water bath and shaken by a wrist-action shaker. After reaction, the flasks were immediately cooled in an ice bath for 120 sec. while being slightly shaken. In this way the temperature of the reaction mixture was rapidly decreased to about 12°C. The residual bromine was then reacted with potassium iodide and the liberated iodine backtitrated with $N/10$ sodium thiosulphate solution.

Table I. Comparison of Hydrochloric and Sulphuric Acid in Pulp Bromination

Reaction time, min.	*Bromine consumption, %*	
	25 ml. N/10 $KBrO_3$–KBr plus 25 ml. N HCl	*25 ml. N/10 $KBrO_3$–KBr plus 25 ml. N H_2SO_4*
20	14.3	13.7
30	15.2	14.6
45	16.4	16.0
60	17.2	17.0

From Table I it can be seen that the bromination rate in the reaction mixture acidified with hydrochloric acid is greater than that acidified with sulphuric acid. As had been found earlier by Hibbert, Maass, *et al.* (*22*), undissociated hydrochloric acid has a catalytic effect on the bromination reaction. In consideration of these findings, hydrochloric acid was used as an acidifying reagent in the experiments reported in this paper.

Of course, a question of importance is that of the amount of acid used, in other words the role of the pH. To study this, two series of experiments were carried out on the same pulp material, using constant bromination conditions, but with variation of the amount of acid added. Hydrochloric acid was used on the one hand and sulphuric acid on the other. The weight of the pulp sample was 0.403 g. in each experiment; 25 ml. $N/10$ potassium bromate-bromide solution was used for bromination. The reaction temperature was exactly 25 ± 0.1°C. and the reaction time 30 min. ± 10 sec. Table II presents the results obtained, namely, the pH measured at the start of the reaction and the milliliters of $N/10$ thiosulphate solution used in the backtitration at the end of the reaction time.

Table II. Influence of Acid Addition (pH) on Pulp Bromine Consumption

Milliliter N acid addition	*HCl-mixture*		*H_2SO_4-mixture*	
	pH	*Ml. N/10 thios.*	*pH*	*Ml. N/10 thios.*
1.	..	..	1.60	2.9
2.5	1.25	12.7	1.41	10.2
5	0.95	17.4	1.20	15.8
10	0.70	17.4	1.00	17.5
20	0.45	17.4	0.78	17.5
25	0.40	17.4	0.70	17.5
50	0.28	17.4	0.45	17.5

From Table II it can be seen that in order to keep the influence of the acidity constant, the pH of the reaction mixture must not be higher than 1. For this reason, in all the following experiments a hydrochloric acid addition was made as to achieve a pH of 1.0. The details of the procedure used are described in the section under "Method."

Reaction Temperature

In preliminary experiments it was found that a temperature difference of 1°C. caused a noticeable deviation in the amount of bromine consumed. Therefore, a constant reaction temperature of 25°C. was chosen and kept constant throughout the reaction. This was achieved by shaking the reaction bottles while immersed in a water bath at 25 ± 0.1°C.

Reaction Time

In a series of experiments, the effect of the reaction time on the bromination rate of unbleached spruce bisulphite pulps, cooked with variation of the yield, was studied. The amount of $N/10$ potassium bromate-bromide solution used was chosen so that the bromine surplus was about 50% at the end of the reaction time. In these experiments the reaction time was varied from 10 to 240 min. The results are presented in Table III and Fig. 1.

Table III. Bromine Consumption versus Reaction Time (50% Bromine-Surplus)

Reaction time, min.	*Bromine consumption, %*		
	Low yield pulp; a (48.0%)	*Medium yield pulp; b (55.7%)*	*High yield pulp; c (76.8%)*
10	4.2	13.3	29.4
20	4.6	14.9	32.4
30	5.0	15.9	34.2
40	5.2	16.3	36.0
60	5.5	17.5	37.1
90	5.9	18.7	38.9
120	6.1	19.4	43.3
240	6.8	21.6	48.2

Figure 1 shows the data of Table III plotted on

log-log scale. Parallel straight lines result indicating that the relationship between reaction time and bromine consumption is that of an exponential function.

Bromine Surplus

To study the influence of the final bromine surplus, another series of unbleached spruce sulphite pulps, with Roe chlorine numbers ranging from 4.3 to 27.1, were subjected to bromination. The reaction time was varied so that the final bromine surplus was in all cases about 70%. The yield figures of the pulps were: A 71.7%; B 65.6%; C 58.5%; D 49.0%. The results are presented in Table IV.

Table IV. Bromine Consumption versus Reaction Time (70% Bromine Surplus)

Reaction time min.	*Bromine consumption, %*			
	Pulp A Roe no. 27.1	*Pulp B Roe no. 17.2*	*Pulp C Roe no. 10.0*	*Pulp D Roe no. 4.3*
30	29.5	20.1	9.2	5.2
45	31.7	21.7	9.7	5.5
90	36.1	24.4	11.1	6.3
180	40.8	27.6	12.6	7.0
360	46.2	31.2	14.3	8.0

The data of Table IV, when plotted on a log-log scale (Fig. 2) resulted in a family of parallel straight lines (full lines). However, their slopes are slightly steeper than those obtained with 50% bromine surplus (Fig. 1).

The question arose, whether, by a further increase in the bromine surplus, the slope of the straight lines would be influenced. To study this, pulps A and B were subjected in another series of experiments to bromination to achieve a bromine surplus of 80%. No noticeable change in the slope of the straight lines

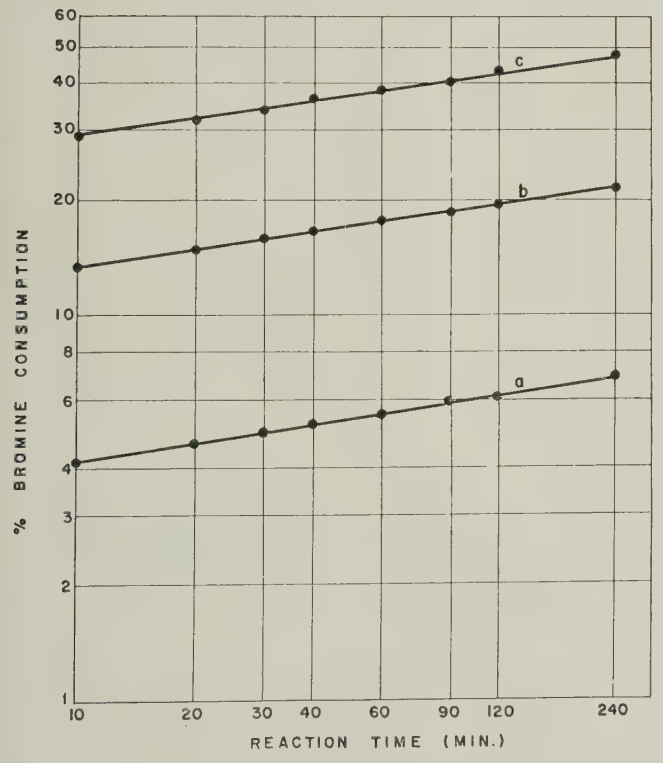

Fig. 1. Bromine consumption versus reaction time (50% bromine surplus)

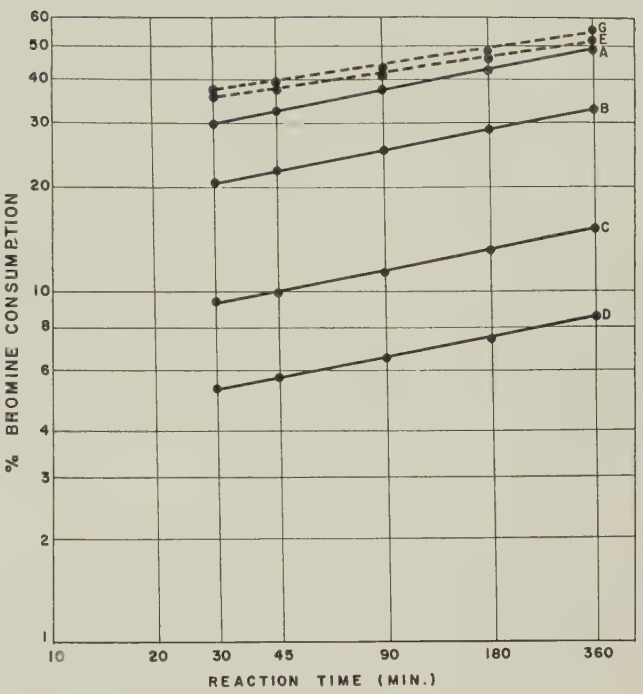

Fig. 2. Bromine consumption versus reaction time (70% bromine surplus)

was found when they were compared with those at 70% bromine surplus.

It is worth noting that a groundwood pulp and a pulp of very high yield (Roe no. 32.0), both of which were subjected to bromination to 70% final bromine surplus (Table V), also exhibited a straight-line relationship between reaction time and bromine consumption when plotted on a log-log scale. However the slope (Fig. 2, broken lines) was found to be less steep than that for pulps with lower Roe chlorine numbers. This seems to be an indication that either the residual lignin of high yield pulps is chemically different, or that the accessibility of the lignin is a factor.

Table V. Bromine Consumption versus Reaction Time (70% Bromine Surplus)

Reaction time, min.	*Bromine consumption, %*	
	92.0% Yield groundwood G (Roe no. 34.9)	*75.5% Yield pulp E (Roe no. 32.0)*
30	36.9	35.3
45	38.9	37.2
90	41.5	40.1
180	45.9	45.2
360	52.3	49.8

The investigations show that although the bromination rate rapidly decreases with increasing reaction time, the reaction even after 2 hr. is still slowly progressing. However, about $^4/_5$ of the total bromine consumption takes place in the first hour. It is evident, that under controlled reaction conditions, a characteristic empirical value of the bromine consumption is found to correspond to each reaction time. Therefore, to obtain reproducible results, the conditions of the bromination, particularly the reaction temperature and reaction time, must be kept constant. Further, the bromine surplus must be at least 70%. In general, a bromination time of 30 min. ± 10 sec. was found to be sufficient in order to get good reproducibility.

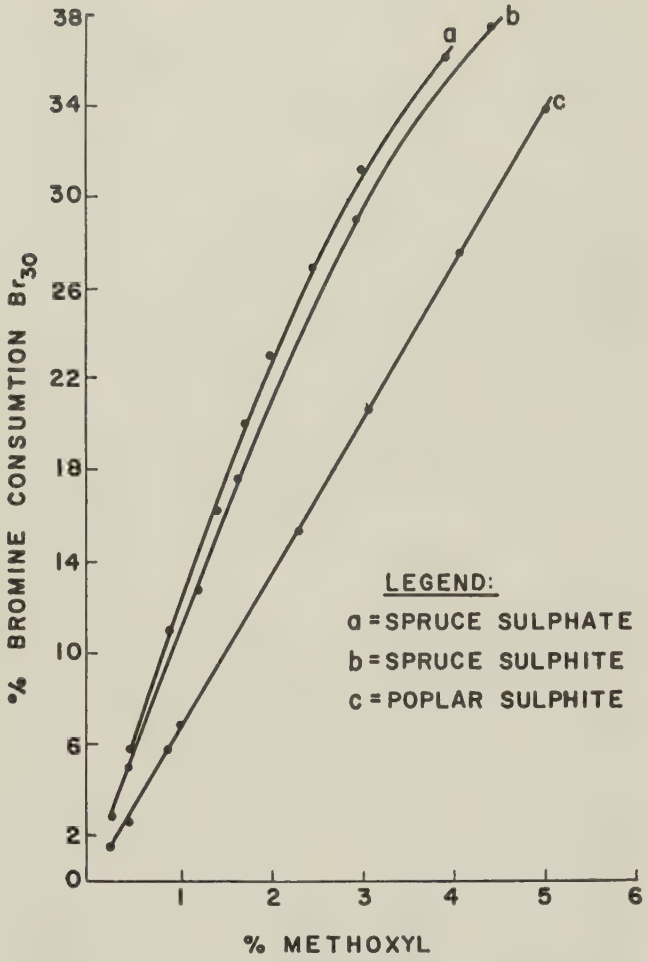

Fig. 3. Pulp bromine consumption versus methoxyl content

The reproducibility can be further improved if the reaction time is extended, for instance, to 1 hr. In order to express clearly what bromination time was actually used, the reaction time in minutes is given with the results. For example, for a bromine consumption obtained in 30 min. reaction time, the designation Br_{30} is used.

Carbohydrate Influence

In pulp bromination the question arises whether the cellulose or hemicellulose portions of the pulp material interfere with the bromine consumption. For a closer examination, the Br_{30} values of several commercial cellulose materials and related fractions were determined. Table VI presents a few of the results obtained.

Table VI. Bromine Consumption (Br_{30}) of Various Cellulosic Materials

Material	*Br_{30} value, %*
Ashless cellulose powder for chromatography (Whatman)	0.01 0.00
Highly purified dissolving pulp	0.01 0.02
Alpha-cellulose	0.00 0.00
Beta-cellulose	0.03 0.04

From Table VI it can be seen that neither the ashless cellulose powder for chromatography (Whatman) nor the highly purified dissolving pulp consumed bromine in the Br_{30} determination. Also, the lignin-free hemicellulose fraction isolated from the highly purified dissolving pulp did not exhibit any appreciable bromine consumption. From these model experiments the conclusion was drawn that lignin-free cellulose and hemicellulose fractions do not in fact interfere with the pulp bromination.

Bromination of Unbleached Pulps

Apparently, the bromine consumption of an unbleached pulp stands in some empirical relationship to its lignin content (*21*) although no absolute bromine consumption value of the lignin substances was found. A similar situation exists also for chlorine number determinations of unbleached pulp materials. This method is not only used as a bleachability test, it is used also as a means for estimating the residual lignin, even in semichemical pulps (*30*) and in high yield kraft pulps (*31–32*).

Unfortunately, no exact measure of the residual lignin in pulp materials exists (*33*). The Klason method results only in an approximate lignin value. Although the combustion factor (*34*) of Klason lignin residues from spruce sulphite pulps was found to be nearly constant, obviously chemical changes occur during the reaction, indicating that differences exist between the residual lignin of the initial pulp and the corresponding Klason lignin residue. Also, a small portion of the lignin substances remains dissolved in the acidic reaction mixture. For this reason it has been suggested that the soluble lignin portions (*35*) be determined and the Klason lignin residue accordingly corrected (*36*). A further source of deviations is the condensation of lignin substances with certain carbohydrate degradation products (*37–38*).

In an earlier study (*39*) a straight-line relationship was found to exist between the bromine consumption and the methoxyl content of low lignin beech sulphite

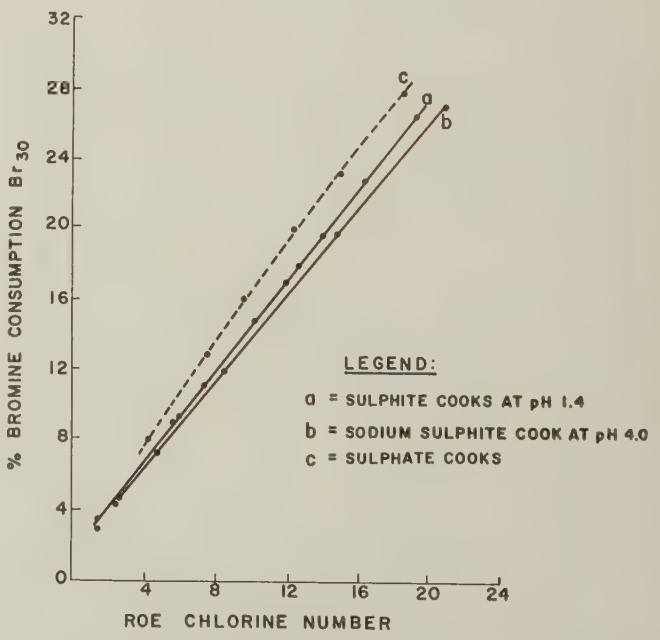
% BROMINE CONSUMPTION Br_{30}
ROE CHLORINE NUMBER
LEGEND:
a = SULPHITE COOKS AT pH 1.4
b = SODIUM SULPHITE COOK AT pH 4.0
c = SULPHATE COOKS

Fig. 4. Spruce pulp bromine consumption versus Roe chlorine number

pulps. These investigations were continued and extended to sulphite and sulphate spruce pulps over a broad range of lignin content. Also, a series of poplar sulphite pulps was studied.

Pulp Bromine Consumption and Methoxyl Content

The Br_{30} and the methoxyl content of the pulps

Table VII. Bromine Consumption (Br_{30}) versus Methoxyl Content of Unbleached Pulps

Pulp material	*Bromine, % (Br_{30})*	*Consumption Atom % 10^3*	*Methoxyl Content % *	*Methoxyl Content Mole % 10^3*	*Atom-mole ratio Br:1 OCH_3*
Na-sulphite pulps	The data have been multiplied by 10^3				
Spruce	2.8	35.0	0.25	8.1	4.7
	5.2	65.1	0.45	14.5	4.5
	10.0	125	0.89	28.7	4.3
	12.8	160	1.21	39.0	4.1
	17.6	220	1.63	52.5	4.2
	29.0	363	2.93	94.4	3.8
	37.4	468	4.41	142	3.3
Poplar	1.4	17.5	0.25	8.1	2.2
	2.6	32.5	0.44	14.2	2.3
	5.8	73.0	0.85	27.4	2.7
	6.8	85.3	1.00	32.2	2.6
	15.3	192	2.30	74.1	2.6
	20.6	258	3.05	98.3	2.6
	27.6	345	4.04	130	2.7
	33.8	423	5.02	162	2.6
Sulphate pulps					
Spruce	5.6	70.1	0.46	14.8	4.7
	11.0	138	0.90	29.0	4.7
	16.1	202	1.44	46.4	4.3
	20.0	250	1.67	53.8	4.7
	23.0	288	1.97	63.5	4.5
	27.9	349	2.42	78.0	4.5
	31.1	389	2.91	93.8	4.2
	36.0	451	3.92	126	3.6

investigated were compared. The results were expressed as atom and mol. per cent, respectively, (these values were multiplied by a factor of 10^3). Also the

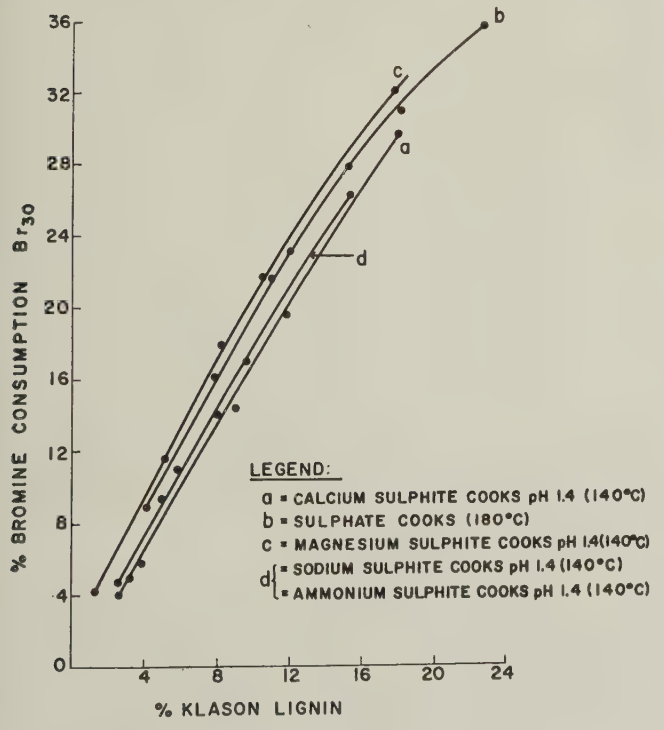
% BROMINE CONSUMPTION Br30
% KLASON LIGNIN
LEGEND:
a = CALCIUM SULPHITE COOKS pH 1.4 (140°C)
b = SULPHATE COOKS (180°C)
c = MAGNESIUM SULPHITE COOKS pH 1.4(140°C)
d = SODIUM SULPHITE COOKS pH 1.4 (140°C)
= AMMONIUM SULPHITE COOKS pH 1.4 (140°C)

Fig. 5. Spruce bromine consumption versus Klason lignin

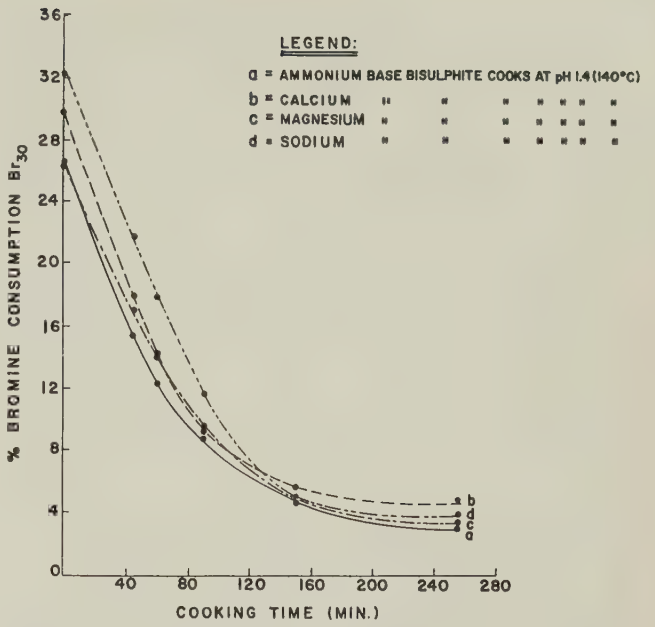

Fig. 6. Spruce pulp bromine consumption versus cooking time

atom-mole ratio of bromine to methoxyl was calculated. The data are presented in Table VII and in Fig. 3.

From Fig. 3 it can be seen that a straight-line relationship almost exists between the bromine consumption and the methoxyl content of unbleached pulps. This relationship is valid over the whole range of poplar sulphite pulps investigated. However a curvature can be seen in the high-lignin range of spruce pulps. It is noticeable that the plots of the spruce sulphite and spruce sulphate pulps exhibit similar, but not identical curves. At the same level of bromine consumption, the methoxyl values are lower in the latter case. The different ratio obtained with spruce and poplar sulphite pulps is probably caused by the difference in the methoxyl content of coniferous and hardwood lignin.

Also, the secondary cell wall of poplar fibers is more accessible and less lignified than that of spruce, as found by Lange (*40*). Although in all the cases of low and medium lignin pulps investigated a straight-line relationship between bromine consumption and methoxyl content was found to exist, the slopes of these straight lines varied.

Pulp Bromine Consumption and Roe-Chlorine Number

Figure 4 shows the relationship between the bromine consumption and the Roe chlorine number of spruce sulphite and spruce sulphate pulps. The straight line a represents sodium, ammonium, magnesium and calcium sulphite pulps cooked at pH 1.4, whereas line b represents sodium sulphite cooking at pH 4. Apparently at pH 1.4 the base does not affect this relationship. However, as a result of using a pH of 4 in sodium sulphite cooking, the straight-line relationship has a different slope. In the series of sulphate cooked pulps, line c, not only is the slope different, but a slight curvature was found also. From Fig. 4 it is apparent that sulphite and sulphate pulps derived from the same wood (spruce) exhibit a different relationship between bromine consumption and Roe chlorine number.

Pulp Bromine Consumption and Klason Lignin Content

Of special interest was the study of the relationship between the Br_{30} and the Klason lignin content of unbleached pulps. A series of spruce ammonium sodium, magnesium and calcium sulphite pulps cooked under the same conditions, at an initial pH of 1.4,

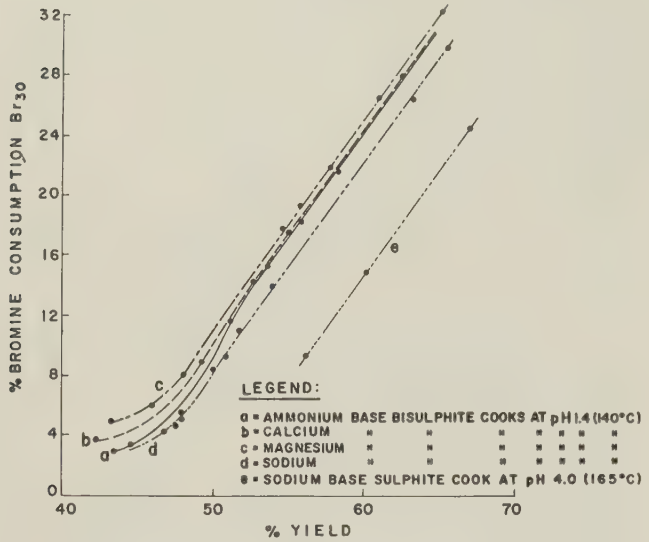
% BROMINE CONSUMPTION Br30
% YIELD
LEGEND:
a = AMMONIUM BASE BISULPHITE COOKS AT pH 1.4 (140°C)
b = CALCIUM
c = MAGNESIUM
d = SODIUM
e = SODIUM BASE SULPHITE COOK AT pH 4.0 (165°C)

Fig. 7. Spruce pulp bromine consumption versus pulp yield

and a series of spruce sulphate pulps were investigated. The results obtained are presented in Fig. 5. As can be seen, up to a lignin content of about 12% a family of straight lines was obtained, exhibiting about the same slope. Remarkably, numerical differences were found to exist even in the sulphite cooking at the same pH (1.4) when various bases were used. However, there are also deviations in each cooking series, probably related to differences of the acid soluble lignin portions of the Klason lignin filtrate. Also, in the series of the kraft pulps, a relationship can be found between the bromine consumption and the Klason lignin content which, however, exhibits noticeable deviations particularly in the high lignin range. These findings indicate that for each set of cooking conditions a distinct relationship exists. In other words, there is no specific relationship between the bromine consumption of unbleached pulps and their Klason lignin content which could generally be used as a basis for a lignin determination. Analogously, this seems to apply also for the relationship between the Roe chlorine number of unbleached pulps and their Klason lignin content.

Examples of Pulp Bromination

Figure 6 shows the decrease of the bromine consumption with increasing cooking time in spruce wood sulphite cooking at pH 1.4, (140°C.), using ammonium, sodium, calcium, and magnesium as bases. Different curves were obtained, indicating that the bases are a factor in the removal of the bromine consuming substances of wood. The pulps corresponding to zero cooking time were obtained by heating to temperature.

In Fig. 7 the relationship between the pulp yield (up to about 65%) and the pulp bromine consumption in the sulphite cooking of sprucewood using various bases, is presented. Within a yield range from about 52 to 65% a family of parallel straight lines was found. In each cooking series the yield drop was proportional to the decrease in the pulp bromine consumption. From Fig. 7 it can also be seen that not only the pH, but also the bases used at constant pH (1.4) influence the yield, and in particular the carbohydrate hydrolysis in the sequence sodium, ammonium, calcium, and magnesium base. At pH 4, the sodium-base liquor resulted in an even higher pulp yield, in spite of the fact that a higher temperature (165°C.) was used. In high yield (above 65%) and low yield pulps (below 50%) the pulp yield drops faster than the pulp bromine consumption.

Figure 8 presents the relationship between the yield and the bromine consumption of a series of spruce pulps cooked with varied cooking times at pH 4 and 165°C. by means of a sodium base sulphite liquor. The corresponding curves of the Klason lignin and the Roe chlorine number can be seen in Fig. 9. From Fig. 8 it is evident that in the first part of the cook the drop in bromine consumption is slow, indicating that carbohydrate portions had been removed. This was also true of sodium-base sulphite cooking at pH 3 and 135°C. (Fig. 10). In this case the cooking liquor contained 12% total SO_2, 6.1% free SO_2, and 5.9% combined SO_2. Heating to temperature was achieved in 10 min. As can be seen from Fig. 10, a slow linear drop occurs in both bromine consumption and Roe chlorine number.

Finally, Fig. 11 shows the bromine consumption of sodium sulphite cooked poplar pulps while the initial

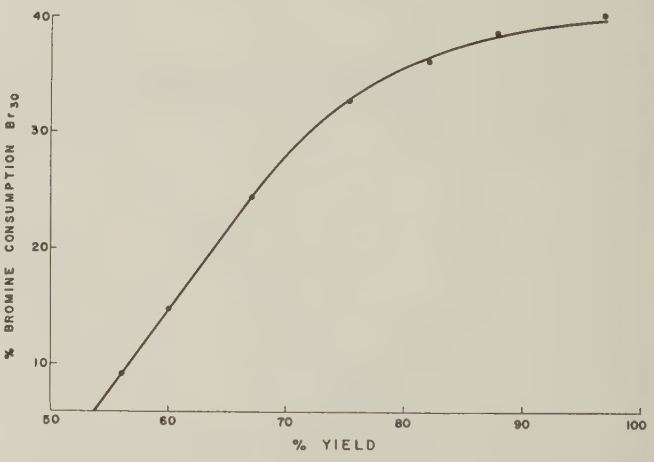

Fig. 8. Spruce pulp bromine consumption versus pulp yield

Sodium sulphite cooking at pH 4.0 (165°C.)

pH of the cooking liquor was varied. The cooking temperature was 140°C.; total time heating to temperature (2 hr.) and cooking at temperature, was 4 hr. The liquor to wood ratio was 7:1.

The Bromination Method

For the determination of the bromine consumption of pulp materials, the following apparatus and reagents are required:

Apparatus:

2 50-ml. burets

1 10-ml. semimicro buret
2 500-ml. iodine flasks
1 25-ml. graduated cylinder
1 wrist-action shaker with constant temperature bath
1 stop watch

Reagents:

0.1 *N* potassium bromate-bromide solution
0.1 *N* sodium thiosulphate solution
1.0 *N* hydrochloric acid
20% potassium iodide solution
5% starch or Thyodene solution

Procedure:

Weigh accurately, in duplicate, 0.400 (±0.002) gm samples of the air-dry pulp. The latter should be ground (Wiley mill) and passed through a 40 to 60 mesh screen. Moisture determination should be done separately. The samples are introduced into dry iodine flasks, and 0.1 *N* potassium bromate-bromide solution (25 ml. or more) is added in such an amount as to result in a final bromine surplus of not less than 70% in the reaction mixture. Then 1.0 *N* HCl (25 ml.), so as to give a pH of 1 at the start of the reaction, is introduced into the flask and the latter is closed quickly and water sealed. The flask is shaken for 30 min. ± 10 sec. at 25 ± 0.1°C. Advantageously, a wrist-action shaker is used, the flasks being immersed in a water bath. After reaction time, the flask is cooled quickly for 2 min. in an ice bath and the water seal is replaced by 10 ml. 20% KI solution. By lifting the stopper, the potassium iodide solution is drawn into the flask which is then re-stoppered and shaken briefly. The iodine surplus is backtitrated with 0.1 *N* sodium thiosulphate solution until the initial color changes to yellow. The stopper and the inside of the flask are washed with distilled water, the wash water directly running into the reaction mixture and starch or Thyodene solution is added. The titration is continued

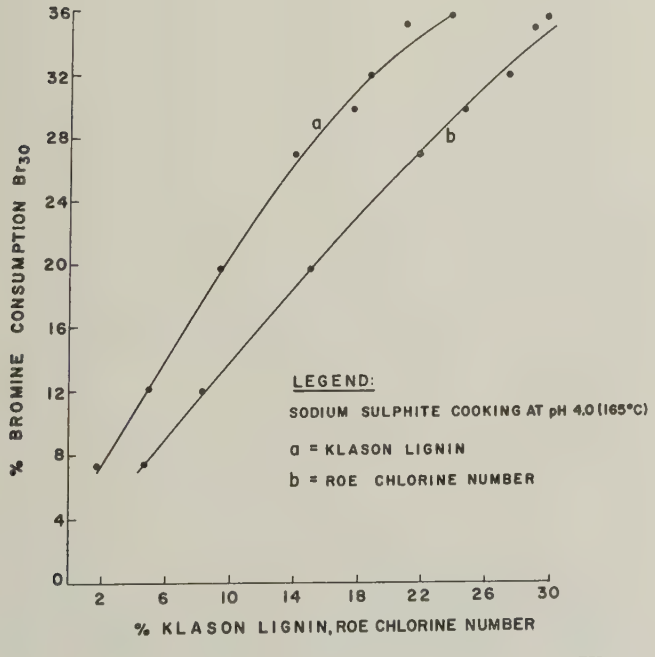

Fig. 9. Spruce pulp bromine consumption versus Klason lignin and Roe chlorine number

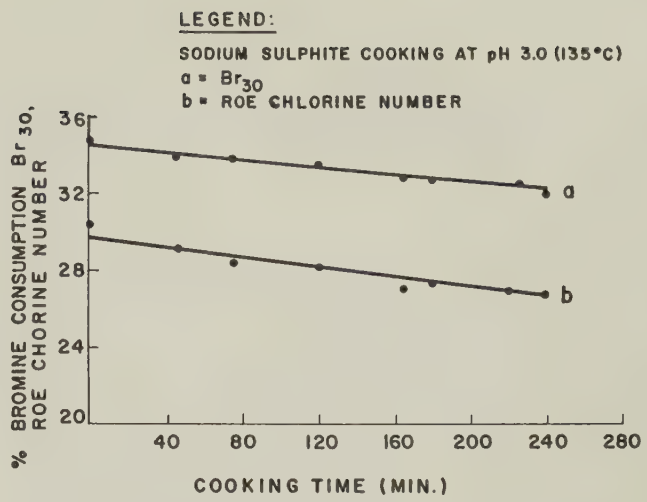

Fig. 10. Spruce pulp bromine consumption and Roe chlorine number versus cooking time

until the blue is discolored, and the bromine consumption is calculated on the oven-dry pulp material. The resulting Br-value must indicate the reaction time used. In the high-yield pulp range it would be advisable to extend the reaction time to 1 hr.

Reproducibility of the Bromine Consumption

To substantiate the reproducibility of the Br_{30} values, a series of 8 brominations of a high-yield, ground and homogenized spruce sulphite pulp was carried out over a period of 4 days, two brominations per day. The results are presented in Table VIII.

Table VIII. Reproducibility of the Bromination of a High Yield Sulphite Pulp

Br_{30}, %	*Deviation from the mean value*
25.42	0.04
25.43	0.03
25.49	0.03
25.50	0.04
25.49	0.03
25.47	0.01
25.44	0.02
25.45	0.01

Table IX shows the reproducibility of the bromine consumption of two ground pulp samples (without preceding homogenization) with 30 and 45 min. reaction time.

Table IX. Reproduction of Pulp Bromination with 30 and 45 Min. Reaction Time

Reaction time	*Pulp F*	*Pulp H*
30 minutes	4.98	26.20
	4.89	26.12
	4.90	26.35
	5.00	26.14
	4.87	26.29
	4.93	26.25
45 minutes	5.21	28.18
	5.15	28.19
	5.21	28.11
	5.20	28.09
	5.18	28.16
	5.17	28.12

DISCUSSION AND CONCLUSION

The bromination method described and used in the

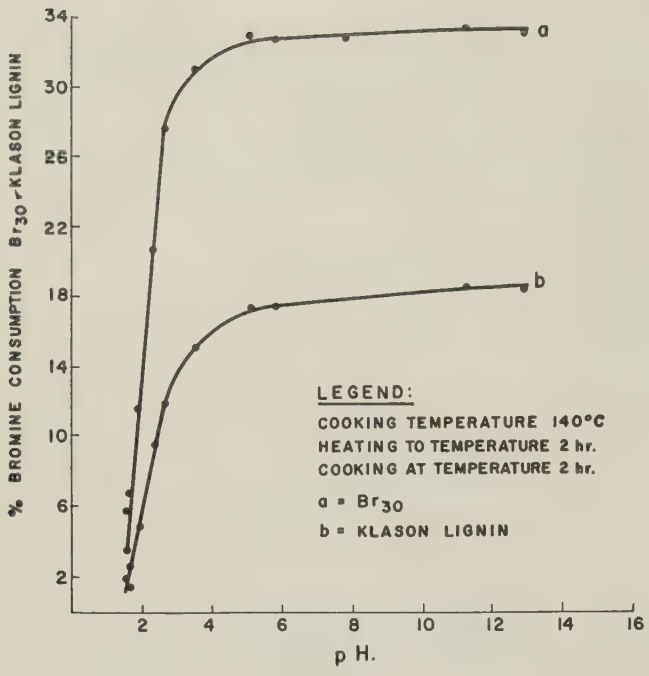

Fig. 11. Bromine consumption and Klason lignin of poplar sulphite pulps versus pH of the cooking liquor

investigations is comparable to the Roe chlorine number-determination insofar as both are based on lignin halogenation and are empirical methods. However, there are also considerable differences. The modified Roe chlorine number determination uses a gas-volumetric procedure, whereas the bromine consumption is titrimetrically determined. In the potassium bromate-bromide solution acidified to pH 1, the bromine is present mainly as bromine cation of high reactivity. In pulp bromination, the extended reaction time (30 min.) together with the constant pH (1.0) and the 70% minimum bromine surplus used, permits good reproducibility, particularly in the low lignin range, where the Roe method is less accurate. Also, it is easier to maintain a constant temperature (25°C.) in the aqueous fiber suspension used in pulp bromination than in the wet pulp sheet during chlorine number determination. In particular, back titration of the liberated iodine permits high accuracy.

For pulps derived from the same wood species and cooked under similar conditions, a straight-line relation was found to exist between the values of the reaction time and the bromine consumption when plotted on a log-log scale. In pulp series produced under the same cooking conditions with variation of the cooking time, a relationship was found between the bromine consumption at constant reaction time (30 min.) on the one hand, and the pulp methoxyl content and the Roe chlorine number on the other. This relationship, however, was found to vary when different wood species and/or different cooking conditions were considered. This applies also to the relationship between the pulp bromine consumption and the pulp lignin content determined according to the TAPPI Standard T 222 m-50. Whereas the bromine consumption of unbleached pulps can be considered to be related to the total of the lignin present, the Klason lignin obviously represents the acid-insoluble lignin portions only. Apparently, there is no consistent relationship between the pulp bromine consumption and the amount of Klason lignin which could be used for practical application.

In general, determination of the bromine consumption of unbleached pulps is considered to be a valuable supplement to the Roe chlorine number determination, particularly in the case of low lignin pulps. The new method was found useful especially when the pulp samples to be analyzed were too small to produce a standard sheet.

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The Methanol-Extractable Materials in Newly Formed Aspenwood

JARRELL B. MUGG

The lignifying tissues of aspenwood (*Populus tremuloides*) were extracted with methanol, and the extractives examined after being fractionated. Evidence has been adduced that phenylalanine, tyrosine, serine, glycine, and sinapaldehyde, which have been suggested to be precursors of lignin, were present in the new xylems collected in 1956. No evidence of six other compounds also considered to be lignin precursors was found. These were shikimic acid, ferulic acid, sinapic acid, coniferyl alcohol, coniferaldehyde, and syringin. Amino acid analyses (Moore-Stein method) indicated that the amounts of free amino acids in mature aspenwood were small relative to the amounts in new xylem. But analyses for sinapaldehyde indicated that both tissues had an appreciable content of sinapaldehyde. These data were thought to show that, if the compounds currently considered as lignin precursors are in fact the precursors of lignin, they may not be formed in the differentiating tissue of aspenwood. Brauns lignin isolated from partially lignified aspenwood was found to resemble closely that prepared from mature aspenwood with respect to infrared and ultraviolet spectra, methoxyl content, and physical appearance. When the infrared spectrum of Brauns aspen lignin was compared with that of Brauns lignin from six other hardwoods and softwoods, similarities and differences were observed between the spectra which did not correlate with botanical classification.

In the past decade, particularly since the development of radio active tracer techniques for following biochemical reactions, numerous experiments have been carried out to obtain information about the biosynthesis of lignin. From a summary of the results, Adler (*1*) proposed a pathway by which lignin may be formed. However, most of the compounds included in this pathway have not been identified widely in woody plants. One reason for this might be that most investigators have studied samples composed predominantly of mature wood, whereas the precursors of lignin may occur in readily detectable concentrations only in the lignifying tissues. Recently Sultze (*2*) reported that the developing tissues of aspenwood (*Populus tremuloides*) contained a material which, because it was water-soluble and gave positive lignin color reactions, i.e., Mäule* and Wiesner reactions, he thought might be a precursor of lignin. Accordingly the methanol-extractable materials present in lignifying aspenwood seemed to be a good starting point both for the further characterization of the Mäule and Wiesner-positive substance found by Sultze and for the detection of the compounds postulated to be precursors of lignin.

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* The chlorine-sodium sulphite color reaction used to distinguish hardwood lignins from softwood lignins is commonly called the Mäule test or reaction, and this usage is followed here. In their book "Cellulose An Outline of the Chemistry of the Structural Elements of Plants with Reference to their Natural History and Industrial Uses" published in 1895, Cross and Bevan state that this reaction is characteristic and they indicate that it distinguishes hardwoods from softwoods. This test might properly have been called the Cross and Bevan test, since Mäule did not publish his results until 1900.

COLLECTION AND PREPARATION OF MATERIALS

Sultze (*2*) separated newly formed aspenwood into three parts of increasing lignin content. These were (1) the xylem scrapings, which were unlignified, (2) the soft xylem, which had an average lignin content of 6.4%, and (3) the newly formed sapwood, termed "new xylem" here, which had an average lignin content of 16.6%. Year-old xylem was shown to have the same lignin content, 20.5%, as that of the average aspenwood. The collection procedures described by Sultze were incorporated in this study. Figure 1 shows the approximate location of each type of tissue taken.

During the 1956 growing season, samples of new xylem and mature (year-old) xylem were taken from 13 trees in the Rhinelander Paper Co. Experimental Forest located south of Eagle River, Wis. The trees were felled during four different trips which were approximately 3 weeks apart. Four trees were cut during the first three trips and one during the fourth. In June, 1957, four more trees were cut and samples were taken of the soft xylem, new xylem, and mature xylem of increasing age, i.e., 1, 2, and 3-yr. old xylem and heartwood (18 to 25 yr. old). Xylem scrapings, soft xylem, and new xylem were taken from a fifth tree. All tissues were collected as described by Sultze (*2*), placed immediately in methanol to stop enzyme activity and macerated at ordinary temperatures until they could be processed in the laboratory. Then the methanol in which the tissue was placed at the time of collection was decanted and the tissue was given two 1-hr. extractions with hot methanol. All three extracts were then combined, filtered to remove fiber fragments, and concentrated under vacuum.

The concentrated methanol extracts were fractionated by Sultze's scheme (*2*). Water was added to each of the concentrated methanol extracts and the residual methanol was removed by vacuum distillation. The resulting turbid, aqueous solution was extracted with hexane and then filtered through a Celite-asbestos pad. The materials remaining in solution were termed the water-soluble materials; those which were filtered out and subsequently redissolved in methanol were called the methanol-soluble materials.

To isolate the Mäule-Wiesner positive material from the sugars and other water-soluble materials, Sultze (*2*) sorbed it on IR-4B ion-exchange resin. A 24-hr. continuous extraction with ether accomplished the same result and was much simpler. The components which remained in the ether were termed the ether-soluble materials; the amber-colored, gummy precipitates which formed in the ether distillation

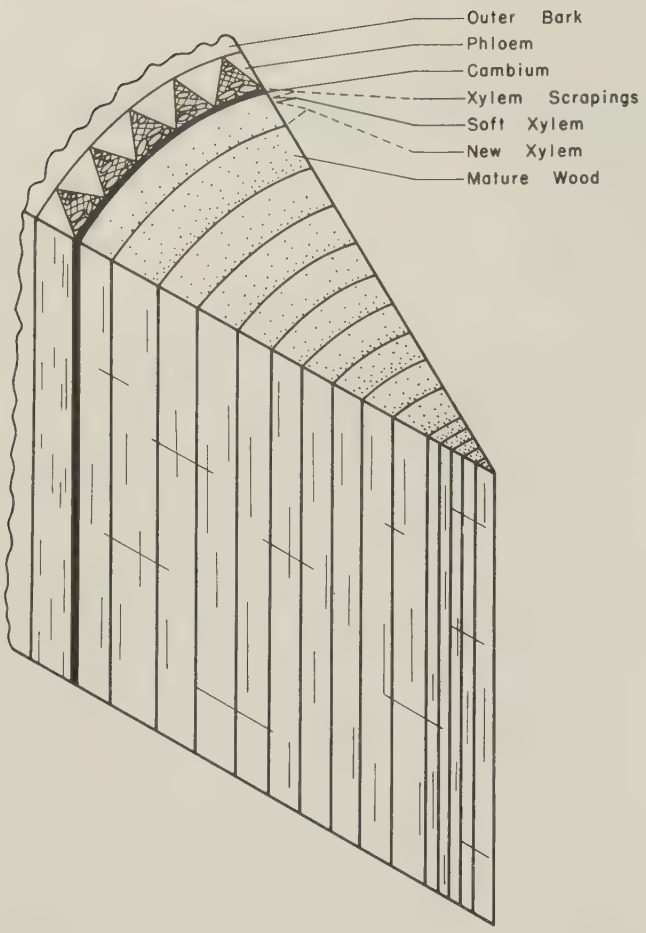

Fig. 1. Cross section of the bole of an aspen tree during the growing season

flasks were termed the precipitates from ether. These were dissolved in methanol after the ether solutions were decanted.

EXAMINATION OF THE ETHER-SOLUBLE MATERIALS

Paper and Column Chromatography

The ether-soluble materials from the new xylem were first chromatographed on paper using the butanol-acetic acid-water (4:1:5) developer recommended by Sultze (*2*). As reported, a spot which gave positive Mäule and Wiesner reactions was found; however, examination of the spot showed that it was not homogeneous. Under ultraviolet light, areas of different color could be seen in the spot, and when it was cut vertically in half and the Mäule and Wiesner tests given separately to the opposite halves, the areas of positive reaction did not correspond. Thus, it was concluded that the spot was actually caused by several materials. This was shown to be true when the ether-soluble materials were chromatographed using a toluene-acetic acid-water (4:1:5) developer (*3*). On these chromatograms, four spots which gave both the Mäule and the Wiesner reactions, and six which gave only the Wiesner reaction were found. Table I shows the locations and reactions of these spots.

Table I. Paper Chromatography of Ether-Soluble Materials

Spot	*Location*[a] R_v[b]	R_{PHBA}[c]	*Mäule reaction*	*Wiesner reaction*
A	0.00	0.00	+	+
B	0.12[d]	0.25	+	+
C	0.030[d]	0.60	−	+
D	0.050[d]	1.00	+	+
E	0.060[d]	1.25	−	+
F	0.20		−	+
G	0.40		−	+
H	0.73		+	+
K	0.92		−	+
L	0.12–0.50 (streak)		−	+

[a] When chromatographed with toluene-acetic acid-water (4:1:5).
[b] $R_{Vanillin}$.
[c] R_p-hydroxybenzoic acid.
[d] Calculated from R_v 0.05 of *p*-hydroxybenzoic acid.

Attempts to isolate larger amounts of individual components of the ether-soluble materials for further study ran into difficulties with paper chromatography, but were more successful with Magnesol column chromatography, by the method of Pearl and Dickey (*4*). An aliquot of the ether solution was evaporated to dryness under reduced pressure and the residue was washed with benzene, in which only those materials causing spots F, G, H, and K were soluble. This step not only effected a partial separation, but also gave distinct zones on the column. The benzene solution containing about 0.75 g. of solids was sorbed on the packing of a no. 3 column and developed with 1200 ml. of a mixture of petroleum ether (b.p. 65–110° C.)—ethanol (50:1). Zones containing the material causing spot H (compound H) and spot K (compound K) were located by streaking the extruded column with the Wiesner reagent. These zones were cut apart, suspended in redistilled acetone, and filtered to remove the Magnesol. The eluted solids were recovered by evaporating the acetone solutions to dryness, dissolved in a few milliliters of chloroform, and freed from traces of Magnesol by filtration through a tightly packed cotton plug in a capillary tube. After a few drops of petroleum ether (b.p. 65–110° C.) had been added, the solutions were set aside in a refrigerator. In time, light tan crystals of compound H, and amber-colored crystals of compound K formed.

Sinapaldehyde

Because compound H gave both the Mäule and Wiesner reactions, it was thought to be sinapaldehyde. Comparison of the compound with an authentic sample of sinapaldehyde showed that both had the same R_f values when chromatographed with the toluene developer and with a water-saturated *n*-butyl ether developer (*5*). The identification was completed when it was determined that the crystals of compound H melted at 105 to 106°C. (uncorrected) (m.p. sinapaldehyde, 109°C., corrected),* and that the points of maximum ultraviolet absorption corresponded with those of sinapaldehyde (243, 348 mmu).

To determine the distribution of sinapaldehyde in aspen xylem, fresh extracts of the xylem collected in June, 1957 were investigated. Paper chromatography of the ether-soluble materials from these extracts showed that sinapaldehyde was present at all stages of wood development. For a quantitative evaluation of this distribution, the concentration gradient of sinapaldehyde across the bole of an aspen tree was determined. For this, the extracts from each type of tissue were combined in order to eliminate variations which may exist between trees. Then aliquots of each

* A mixed melting point with authentic material was not made owing to paucity of material.

Table II. Distribution of Sinapaldehyde Across the Bole of an Aspen Tree

Tissue	*Sinapaldehyde content,*[a] *%*
Soft xylem	0.026
New xylem	0.063
Year old xylem	0.013
Two-year-old xylem	0.010
Three-year-old xylem	0.009
Heartwood	0.009

[a] Based on the oven-dry, unextracted wood.

solution were streaked across the top of strips of Whatman no. 1 paper, and the strips developed with the toluene developer. The bands of sinapaldehyde were easily located by their fluorescence under ultraviolet light, cut out, and eluted with purified 95% ethanol (*6*). After bringing the eluates to 10-ml. volumes, the concentration of sinapaldehyde in each was calculated from the ultraviolet absorption measured at 348 mmu. Table II gives these values.

Coniferyl Alcohol and Coniferaldehyde

When compound K was chromatographed beside authentic coniferaldehyde in toluene and butyl ether developers, the two materials were found to have the same R_f values. However, the crystals of compound K decomposed at 205 to 208°C. instead of melting at 82°C., the melting point of coniferaldehyde. Moreover, the infrared spectrum of the compound was not similar to that of coniferaldehyde. Thus, the compound was not coniferaldehyde.

Because coniferyl alcohol is very easily oxidized, a special sample of new xylem was collected, placed immediately in refrigerated methanol, and kept at 0°C. until the laboratory manipulations could be done (about 24 hr.). Then the methanol solution was decanted and concentrated under vacuum at room temperature. Chromatography of this extract with butanol containing 2% ammonia (*7*), followed by spraying with bis-diazotized benzidene (*8*) revealed no spot at R_f 0.79, where coniferyl alcohol should have been located (*9*).

It was also observed that when this refrigerated extract was chromatographed with the toluene developer, and sprayed with the Wiesner reagent, all of the spots listed in Table I were found except compound K. However, the compound was found when the tissue was subsequently re-extracted with hot methanol.

Aromatic Acids

Ferulic and sinapic acids were included in the proposed pathway for lignin biosynthesis (*1*), and *p*-hydroxybenzoic acid has been reported to be a major component of the extractives of aspenwood (*10*). Therefore, the ether-soluble materials from the xylem scrapings, soft xylem, and new xylem were examined for these acids. For this, the three ether solutions were extracted with 6% $NaHCO_3$ solution. The aqueous extracts were then acidified to liberate organic acids, and the latter were re-extracted with ether. Paper chromatography revealed that the ether extracts of the three xylems contained an acid which corresponded to *p*-hydroxybenzoic acid, but there was no evidence of the two other acids.

Hydroaromatic Acids

Four hydroaromatic acids, 5-dehydroquinic acid, 5-dehydroshikimic acid, shikimic acid, and prephenic acid, are thought to be the intermediates in the biosynthesis of the phenylpropane lignin monomers from carbohydrates (*1*). To determine if any of these acids were present in lignifying aspenwood, the ether-soluble materials from the xylem scrapings, soft xylem, and new xylem were chromatographed by Whiting's procedure (*11*). The soft xylem extract gave a spot at R_f 0.49, but no other spots were found. An authentic sample of shikimic acid was found to have an R_f of 0.53. None of the other three hydroaromatic acids were available for comparison, nor was any mention of their chromatographic properties found in the literature.

EXAMINATION OF WATER-SOLUBLE MATERIALS

Paper chromatography of the water-soluble materials using the butanol-acetic acid-water (4:1:5) developer, followed by spraying with ninhydrin showed that a large number of amino acids were present. Since five amino acids, phenylalanine, tyrosine, methionine, serine, and glycine, are thought to take part in the biosynthesis of lignin (*1*, *12*) it seemed desirable to make an analysis for the compounds by the method of Moore and Stein (*13*). The water-soluble materials from the new xylem and the year-old xylem of a tree felled in July, i.e., near the middle of the growing season, were used. Color peaks representing 13 amino acids were observed, of which 11 including those corresponding to phenylalanine, tyrosine, serine, and glycine, indicated significantly greater amino acid concentrations in the new xylem (i.e., lignifying tissue) than in the year-old xylem (i.e., mature wood). No peak corresponding to methionine was observed. Table III gives the results of this analysis.

Confirmation of the presence of phenylalanine and tyrosine was obtained by comparing a two-dimensional chromatogram of the water-soluble materials from new xylem with one on which phenylalanine and tyrosine had been spotted. The developers used were those suggested by Wolfe (*14*).

In addition to the sugars and amino acids found in the water-soluble materials, one Mäule-positive material was found. It was thought that this material might be syringin, but when it was chromatographed beside a sample of syringin, no similarity could be seen. No evidence of syringin could be found, although it was shown that the Mäule test, which was used to detect this compound, would produce a visible reaction on a

Table III. Analysis of Acidic and Neutral Amino Acids in Aspenwood by the Moore-Stein Method

Peak corresponding to:	*Concentration,*[a] *%*	
	New xylem	*Year-old xylem*
Aspartic acid[b]	0.009	0.002
Glutamic acid	0.009	0.002
Serine	0.009	0.001
Proline	0.007	0.0002
Glycine	0.002	0.0003
Alanine	0.003	0.0005
Threonine	0.0000	0.001
Cystine	0.002	0.0001
Valine	0.004	0.0002
Isoleucine	0.002	0.0003
Leucine	0.002	0.002
Tyrosine	0.002	0.0002
Phenylalanine	0.002	0.0001

[a] Based on the oven-dry, unextracted wood.
[b] These results were not directly controlled with a known mixture of amino acids. However, the columns had been tested and operated satisfactorily by G. A. Dubey, Jr., for the analysis of yeast hydrolyzates.

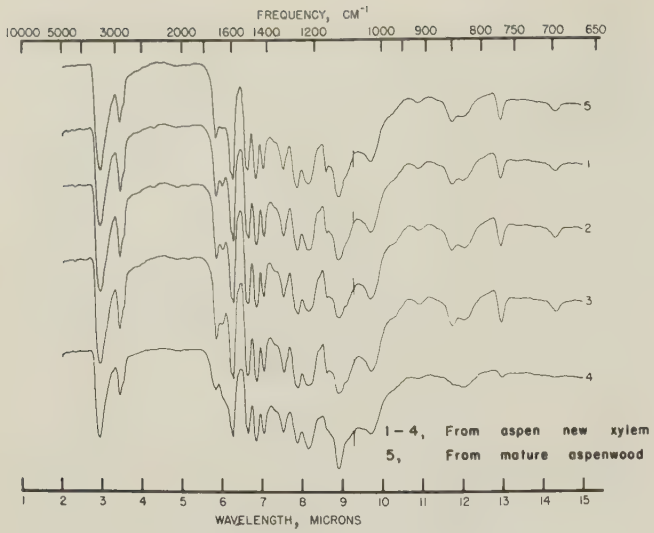

Fig. 2. Infrared spectra of five preparations of Brauns aspen lignin

chromatogram with as little as 10^{-7} moles of syringaldehyde.

EXAMINATION OF THE METHANOL-SOLUBLE MATERIALS

Because both the methanol-soluble materials and Brauns lignin are Wiesner-positive, Mäule-positive, soluble in methanol and insoluble in water or hexane, the two preparations were compared on chromatograms. For this comparison, a sample of Brauns lignin isolated from mature aspenwood by Leaf (*15*), was available. None of the three developers used, toluene-acetic acid-water (4:1:5), butanol-acetic acid-water (4:1:5), or metacresol-acetic acid-water (50:2:48), revealed any significant differences between the two materials.

For a preparative study, the methanol-soluble fractions from the new xylem taken in 1956 were combined into four solutions corresponding to the four collection periods of that year. Each consolidated solution was then subjected to Brauns procedure (*16*). Three of the preparations were light, tan powders which resembled Leaf's sample. That from the fourth period differed in that it dried to hard, brown lumps which were not completely soluble in the 95% ethanol. Determinations of the methoxyl content (TAPPI Standard T 2 m-43), infrared spectrum, and ultraviolet spectra in both neutral and alkaline solution were carried out for each of the preparations from new xylem. Only the infrared and ultraviolet spectra were determined for Leaf's preparation since the methoxyl content was reported as 19.5% (*15*). The infrared and ultraviolet spectra were obtained by the use of a Perkin-Elmer Model 21 recording spectrophotometer and a Beckman DU recording spectrophotometer, respectively. Table IV gives the methoxyl content of each preparation; the average value excluding sample IV was 20.3%. The infrared and ultraviolet spectra are given in Figs. 2, 3, and 4.

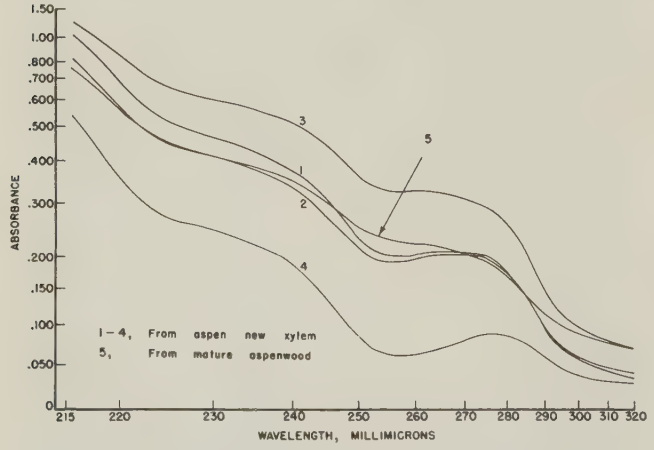

Fig. 3. Ultraviolet spectra of five preparations of Brauns aspen lignin, solvent: 95% ethanol, solution concentrations: 1, 11.75 mg./l.; 2, 9.67 mg./l.; 3, 11.84 mg./l.; 4, incompletely dissolved; 5, 8.24 mg./l.

Table IV. Methoxyl Content of Brauns Lignin from Aspen New Xylem

Tissue collection period	*Methoxyl content of Brauns lignin from tissue, %*
I	20.6
II	19.9
III	20.4
IV	22.8

DISCUSSION

Biosynthesis of Lignin

Evidence has been adduced for the presence in lignifying aspenwood of three of the compounds included in the proposed pathway of lignin biosynthesis; no evidence was found of six others. This does not necessarily mean that the pathway does not represent the way in which lignin is formed. However, it does appear to indicate that if the pathway is correct, then Wardrop's conclusion that the lignin precursors arise within the differentiating tissue (*17*) is in error, or else, that many of the precursors are so transitory as to be undetectable. While it is possible that some of the precursors of lignin are never present in identifiable quantity, this is probably not true in all cases. Therefore, the absence of the six compounds is more likely due to one of the first two assumptions.

The mere presence in lignifying tissue of amino acids, e.g., phenylalanine, tyrosine, serine, and glycine, does not prove that they are participating in lignification reactions since they may be acting as part of the protein cycle which occurs in all plants (*18*). If ferulic and sinapic acids had been detected, their presence would

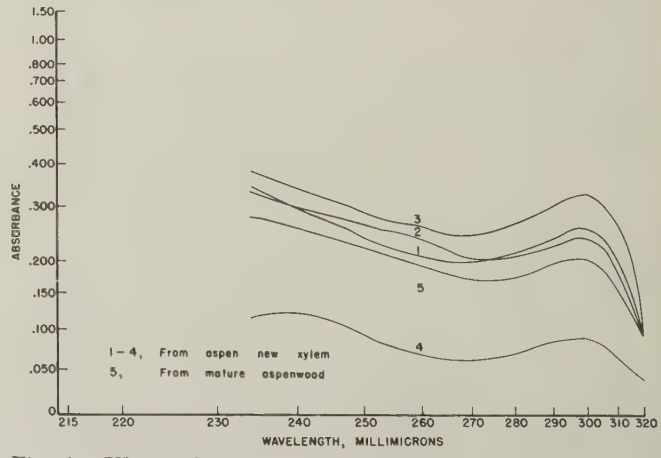

Fig. 4. Ultraviolet spectra of five preparations of Brauns aspen lignin, solvent: 95% ethanol containing 1.0N potassium hydroxide, solution concentrations: 1, 11.75 mg./l.; 2, 9.67 mg./l.; 3, 11.84 mg./l.; 4, incompletely dissolved; 5, 8.24 mg./l.

have strengthened the hypothesis that phenylalanine and tyrosine are supplying C_6-C_3 structures, and that serine and glycine are supplying CH_3 groups for methoxylation of phenols. The fact that fully lignified wood contains less nitrogen than immature xylem (*2*) shows that at least some of the protein has been broken down and nitrogen transported to another part of the tree. By analogy to other instances in which nitrogen depletion occurs, one might expect the transformation of the aromatic amino acid skeletons into lignin.

The occurrence of sinapaldehyde in the zone of lignification shows that the compound is either being formed there or is being transported to that tissue from some other part of the tree. From its concentration gradient across the bole of the tree, it is apparent that the sinapaldehyde does not accumulate, and may be combined into an insoluble substance before the wood matures. The positive Wiesner reaction of lignin is indicative that the compound may be joined to lignin as an end group.

The origin of the sinapaldehyde is not known, but two possible ways by which it may be formed have been suggested. According to Wardrop (*16*), the entire biosynthesis of lignin takes place within the cell undergoing lignification, in which case the sinapaldehyde could be an intermediate in the reduction of sinapic acid to sinapyl alcohol as Adler (*1*) proposed. This sequence is analogous to the reduction of glyceric acid to glycerol, which is a known biochemical reaction (*19*).

A different hypothesis was advanced by Freudenberg (*20*), who postulated that only the final stages of lignification occur *in situ* and that the biosynthesis of the "primary lignin building stones," i.e., coniferyl and sinapyl alcohols in the form of their glucosides, occurs elsewhere in the tree. In support of this view, he showed that when coniferyl alcohol is treated with mushroom oxidases, three dehydro-dimeric oxidation products of coniferyl alcohol and a small amount of coniferaldehyde are formed in the first stages of the reaction which eventually yields an insoluble polymer (DHP) which resembles softwood lignin (*21*). Freudenberg termed all four compounds "secondary lignin building stones." However, it is more likely that only the three dimers should be included in that designation since the small quantity of coniferaldehyde which is formed (less than 1%) is probably due to a side reaction.

The occurrence of free sinapaldehyde in the formative stages of aspen xylem without any indication of the simultaneous occurrence of closely related compounds presents a paradox which can be rationalized to some extent by the following considerations. Aspen lignin, like other hardwood lignins, is regarded as a copolymer of coniferyl and sinapyl alcohols. Regardless of which of the two postulates about the sequence of lignification one may favor, the radicals of both coniferyl and sinapyl alcohols are present in the end product, lignin. Alkaline nitrobenzene oxidation indicates that the syringyl radical predominates over the guaiacyl radical in aspen lignin in the ratio 3:2 (*22*). Under these circumstances, one can postulate that coniferyl alcohol is a critical, rate-controlling factor because the sinapyl alcohol is always in excess of the 1:1 ratio required for the formation of a DHP which resembles hardwood lignin. Hence, only sinapyl alcohol is exposed appreciably to the side oxidation reaction by which an aldehyde is formed.

From the observation that the highest concentration of sinapaldehyde was found in new xylem, it follows that this aldehyde does not accumulate beyond a limited extent. The characteristic Wiesner reaction of lignin is attributed to the R—CH=CH—CHO group (R = phenolic radical). If sinapaldehyde were involved in the lignin "polymerization" to a limited extent, it would explain the Wiesner test.

Brauns Lignin

The comparison of the Brauns lignin isolated from lignifying aspenwood with that from mature aspenwood shows that Brauns lignin is formed quite early during cell differentiation. The significance of this cannot be stated since the true nature of Brauns lignin has not been proved. Concerning this, however, it should be noted that the materials which precipitated from the ether extracts had the same chromatographic properties as the Brauns lignin but were not precipitated from aqueous solution. Thus, they apparently had the same type of structure as Brauns lignin but must have a much lower molecular weight. From this, it may be hypothesized that Brauns lignin and the precipitates from ether are both composed of partially polymerized lignin building stones. The failure of these materials to attain the molecular size of insoluble lignin could possibly be due to end group reactions between the aliphatic hydroxyls of the lignin building stones and *p*-hydroxybenzoic acid, which is a major component of the extractives of aspen (*10*). The presence of such esters in Brauns aspen lignin has been suggested by Smith.

An item worthy of note is the similarity of the infrared spectra of the Brauns aspen lignin and that of Brauns lignin isolated from black spruce and slash pine by Lyness and Schenker (*23*), and the difference between these spectra and those given by the Brauns lignin prepared from maple, oak, birch, and white Scots pine by Nord and Schubert (*24*). The first three preparations all had a significantly stronger hydroxyl band (3.0 mu) than aliphatic carbon band (3.4 mu), while just the opposite was true for the last four spectra. This difference does not correlate with the botanical classification of the trees. It should warrant further investigation.*

SUMMARY

Recent advances in biochemistry have led to the construction of a hypothetical pathway of lignin formation. The foregoing investigation of the substances extracted by methanol from lignifying aspenwood was intended as a test of this hypothesis and was based on the assumption that the compounds participating in the formation of lignin could be detected in the tissues undergoing lignification. The data provided affirmative evidence that phenylalanine, tyrosine, and sinapaldehyde were present in the new xylem (summer of '56) of aspenwood. But no affirmative evidence was noted for the presence of shikimic acid, ferulic acid, sinapic acid, or coniferaldehyde. These compounds are among those postulated in the sequence leading to

* The cation of physical and chemical constants does not imply that Brauns lignin is thought of as a homogeneous entity (*25*).

coniferyl and sinapyl alcohols, i.e., the compounds considered to be the "primary building stones" or "monomeric units" of lignin. A material closely resembling "Brauns lignin" from mature aspen was present in new xylem early (June) in the growing season. Accordingly, such congruence as was indicated between hypothesis and the occurrence of lignin precursors obtained only for an early (amino-acid) stage and a late (Brauns lignin) stage.

The presence of sinapaldehyde coupled with the apparent absence of sinapyl alcohol, coniferyl aldehyde, and coniferyl alcohol presents a paradox. Since Freudenberg has stated that sinapyl alcohol is not "polymerized" by mushroom oxidase unless coniferyl alcohol is present, the amount of the latter alcohol present can be thought of as determining the amount of sinapyl alcohol converted to lignin. Any excess of sinapyl alcohol might then be acted on by another oxidizing enzyme and appear as sinapaldehyde.

A Brauns lignin was present in the first aspenwood new xylem collected (June, '56) and it may be inferred that this material is a concomitant of active lignification. It was noted that the relative intensities of the infrared absorption bands for hydroxyl group (3.0 mu) and for aliphatic carbon (3.4 mu), recorded in the literature for various Brauns lignins do not parallel the classification (hardwood versus softwood) of the trees from which the lignins were obtained. This disparity warrants further study.

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Use of CMC as a Coating Adhesive

HARRY KOHNE, JR.

Low viscosity laboratory manufactured CMC samples were compared with commercially available samples as the single adhesive in clay coating colors. Low viscosities were obtained by two methods. The first was acid degradation of the original pulp. The second was a combination of alkali aging and air oxidation. Sheet brightness and opacity were good for all of the CMC colors. Sheet finish was a function of both absolute viscosity of the CMC and the method of viscosity reduction. Adhesive strength was definitely lowered by both methods of viscosity reduction.

Some time ago, West Virginia was considering the possibility of using carboxymethyl cellulose as a coating adhesive for some specific grades of coated paper. One phase of this question was concerned with the use of CMC as the sole adhesive in a printing paper coating formulation. At that time, we considered the possibility of manufacturing the CMC to our own specifications.

We had had some experience with CMC formulations in the laboratory and realized that for our purposes, the viscosity-solids relationships for the colors would be very important. We knew that a considerable amount of viscosity reduction would be necessary before the CMC would be suitable for our needs. On the other hand, we were obviously interested in getting as high a binding power from the adhesive as possible.

This work was concerned with the manufacture of CMC, and two methods of reducing its viscosity to meet our coating manufacturing specifications. This report is not intended to cover the details of the CMC manufacturing and modifying processes themselves. Rather its purpose is to present and discuss the qualities of the CMC and the resulting colors obtained in this work.

The first method of viscosity reduction was acid hydrolysis of the original pulp before carboxymethylation. The second method was a combination alkali aging and air oxidation of the CMC after its manufacture.

PROCEDURE

As a result of a considerable amount of preliminary work, a standard procedure for the laboratory manu-

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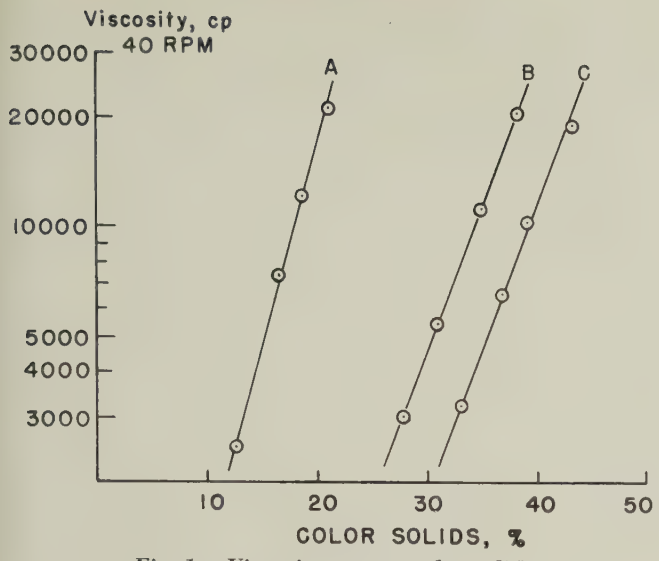

Fig. 1. Viscosity versus color solids

A—"High" viscosity CMC. B—"Medium" viscosity CMC. C—"Low" viscosity CMC.

facture of CMC was adopted. It consisted of the following steps. The pulp was first conditioned at 72°F. and 50% R.H. It was then shredded in the Readco mixer with water, sodium hydroxide, and isopropyl alcohol. The shredding continued for $1^1/_2$ hr.

The required amount of monochloroacetic acid was added to this alkali cellulose over a period of $1^1/_2$ hr. in the same mixer. The batch was cooled for the entire 3 hr. with 5°C. water flowing through the mixer jacket.

The mixer temperature was then raised to 50°C. and the carboxymethylation allowed to take place. The water-to-pulp ratio for all runs was 0.4. The alkali-to-pulp ratio was 0.35. The alkalinity was 11.5%.

For the acid treatment of the pulp before carboxymethylation the following procedure was used:

The pulp was diluted with water to 2% consistency. The proper amount of hydrochloric acid (36.5–280 g. per 100 g. pulp) was added to this slurry. Temperature of the batch was maintained between 58 and 60°C. and the treatment time varied from 1.5 to 10 hr. The batch was agitated continuously during this treatment. The pulp was then washed, filtered, dried, and conditioned. Carboxymethylation was done by the previously described procedure for 3 hr. at 58°C.

For the alkaline aging treatment of CMC, the required amounts of water and sodium hydroxide were added directly to the finished CMC batch in the Readco mixer. After thorough mixing, the material was transferred to separate containers where the proper amount of air was introduced. The alkalinity for this aging process was varied from 5 to 20% and the water-to-CMC ratio was kept constant at 1.4. The aging time was 10 hr. in all cases.

Pulp viscosity was determined by the TAPPI falling ball method using cupriethylenediamine solution. CMC viscosity was determined, after suitable purification, at 2% oven-dry solids in water. The Hoeppler precision viscosimeter was used.

The procedure used for color making with the CMC was as follows:

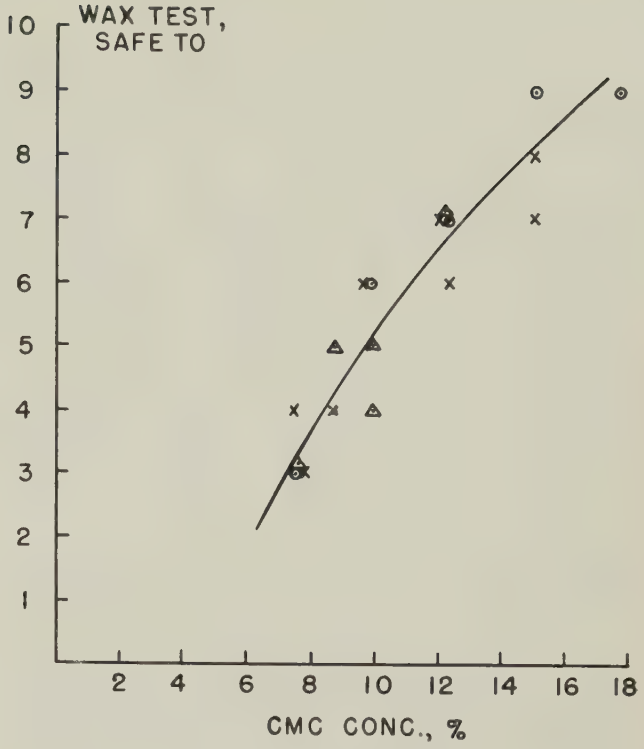

Fig. 2. Wax test versus CMC concentration

×—Low viscosity CMC. ⊙—Medium viscosity CMC. △—High viscosity CMC.

Clay was dispersed in water with TSPP at 72% solids with a high shear dough mixer. The CMC was dispersed separately in water with hand mixing. The solids varied from 2 to 7% and were as high as was considered practicable. After complete solution of the CMC, it was mixed with the clay slip for 20 min. in a high-speed mixer. This was the finished color and was applied to paper for supercalendering and subsequent testing.

Color viscosity was determined with the McMichael viscosimeter at 40 r.p.m.

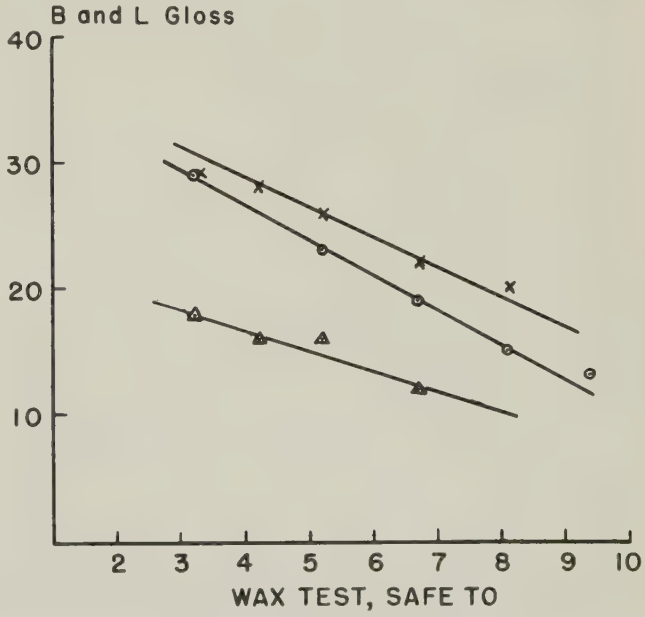

Fig. 3. Gloss versus wax test

×—Low viscosity CMC. ⊙—Medium viscosity CMC. △—High viscosity CMC.

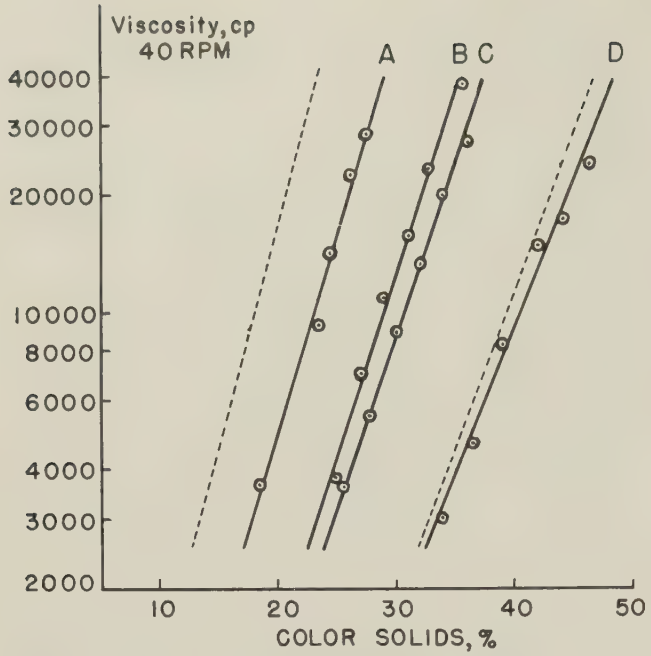

Fig. 4. Viscosity versus color solids; 10% CMC on clay

A—CMC viscosity—1332 cp. B—CMC viscosity—292 cp. C—CMC viscosity—116 cp. D—CMC viscosity—24 cp. ----- Commercial CMC.

RESULTS

Standard, commercially available CMC samples were examined first to give a bench mark or starting point with our clay, paper, make-down procedure, etc. The samples selected were a high and a medium viscosity sample from one manufacturer and a low viscosity sample from a second manufacturer.

The viscosity-solids relationships for typical coating colors made from these three CMC's are shown in Fig. 1. Here we see the well known semilogarithmic relationship between color solids and viscosity for any given CMC. This figure gives a good visual comparison of the three samples. It is obvious that the medium viscosity material is closer to the low than it is to the high viscosity CMC. At a constant color viscosity of 5000 cp., the color solids are seen to vary from 15 to 35%.

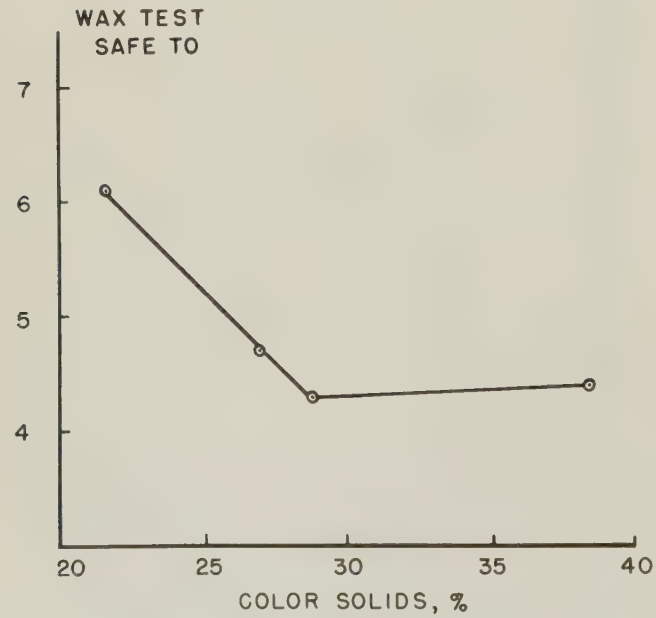

Fig. 5. Wax test versus color solids

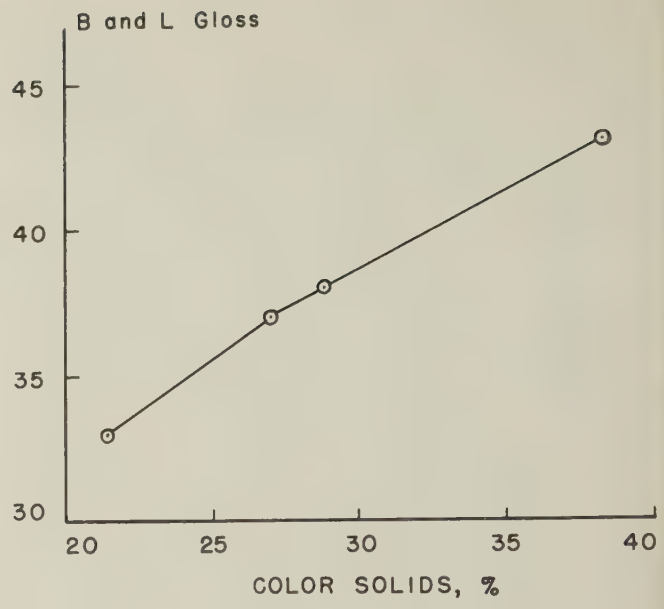

Fig. 6. Gloss versus color solids

The coated paper showed good brightness and opacity when compared with our normal starch coatings. At equal wax test values, we found approximately 2 units of brightness advantage for the CMC over starch.

Figure 2 shows the bonding strength as a function of CMC concentration for the three CMC's. Strength was measured with Dennison waxes. The results were confirmed later with a film splitting-type pick tester. These data showed a reasonable increase in surface strength with increased adhesive concentration. There was very little difference in bonding strength among the three CMC's. With our particular set of conditions, 11% of adhesive was required to give a sheet safe to a no. 6 wax.

Figure 3 shows the effect of CMC concentration, plotted here as wax test, on the final sheet finish, shown here as B. & L. gloss. These curves show the well known effect of finish loss with adhesive concentration or wax test increase. More significantly, they show that an increase in finish occurs as the CMC viscosity is lowered. In all cases the gloss was poorer than for our normal starch coatings at the same wax test.

Our first attempts at viscosity reductions were made by acid degradation of the pulp before carboxymethylation. Table I shows the range of viscosities obtained by this method.

TAPPI pulp viscosity varied from 10 to 44 and the resulting CMC viscosities (centipoises of a 2% solution) varied from 24 to 1332. The solids-viscosity curves for colors made from these CMC's are shown in Fig. 4. Here it can be seen that the color solids varied

Table I. Pulp Viscosity and Resulting CMC Viscosity

	Sample no.			
	1	*2*	*3*	*4*
Pulp viscosity, TAPPI	44	33	21	10
CMC viscosity, 2% solution, cp.	1332	292	116	24

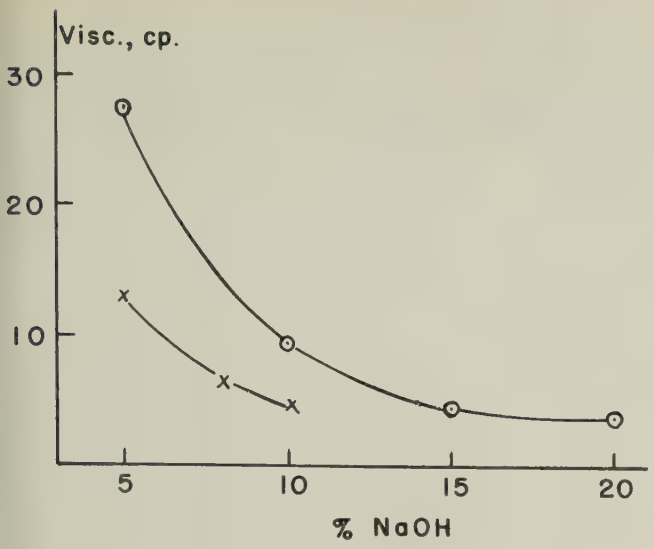

Fig. 7. CMC viscosity versus alkali concentration

⊙—30 p.s.i. air pressure. ×—85 p.s.i. air pressure.

from 20 to 36.5% at 5000 cp., or practically the same as the commercial samples used as original guides. Again we note a semilog relationship between color solids and viscosity.

Figure 5 shows the bonding strength of these CMC's as a function of color solids at constant viscosity. The color solids values were taken from Fig. 4 at the constant viscosity line of 5000 cp. This is, of course, equivalent to plotting wax test versus a function of CMC viscosity. Here it can be seen that the first acid degradation resulted in a fair drop in wax test but that the surface strength remained essentially constant for further degradations.

The effect of CMC viscosity on the supercalendered paper gloss or finish is shown in Fig. 6. Here it can be seen that there is a significant increase in finish with increase in color solids (or decrease in CMC viscosity). The total range is approximately 10 units. The three thinnest CMC's gave coated sheet gloss higher than the standard starch color used for comparison.

Here again brightness and opacity were both better for the CMC than for typical starch colors.

Our next attempt at CMC viscosity reduction was by the alkali aging of the finished CMC in the presence of excess air at increased air pressure. The data obtained from these experiments are shown in Table II. Here the alkali concentration ranged from 5 to 20% and the air pressure ranged from 30 to 125 p.s.i. The final viscosities of the CMC produced by this method ranged from 3.8 to 27.4 cp.

Figure 7 shows how the CMC viscosity varies with per cent alkalinity and with air pressure. Here it can be seen that the alkali has a significant effect in

Table II. CMC Aging Conditions

Sample no.	*% Alkalinity*	*Air Pressure*	*CMC viscosity*
1	10	30	9.4
2	5	30	27.4
3	20	30	3.8
4	15	30	4.5
5	5	85	13.2
6	10	85	4.6
7	8	85	6.5
8	6	125	7.7

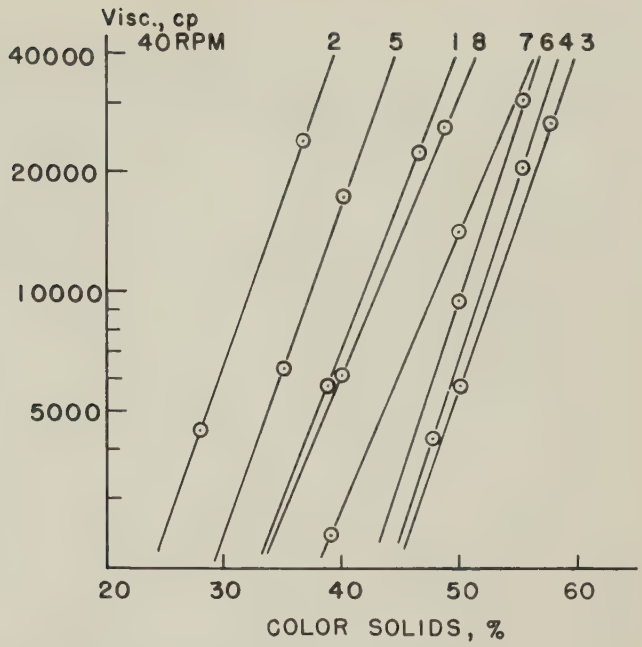

Fig. 8. Viscosity versus color solids; 15% CMC on clay

reducing CMC viscosity up to a concentration of approximately 15%. The effect then drops off rapidly. The top line of this figure shows viscosity for the 30 p.s.i. series and the bottom line for the 85 p.s.i. These curves show that increased air pressure has a significant ability to reduce CMC viscosity. Over the alkalinity range covered, it can be seen that the increase from 30 to 85 p.s.i. reduces the viscosity by about 50% at any constant alkalinity.

The solids-viscosity data for the colors made from

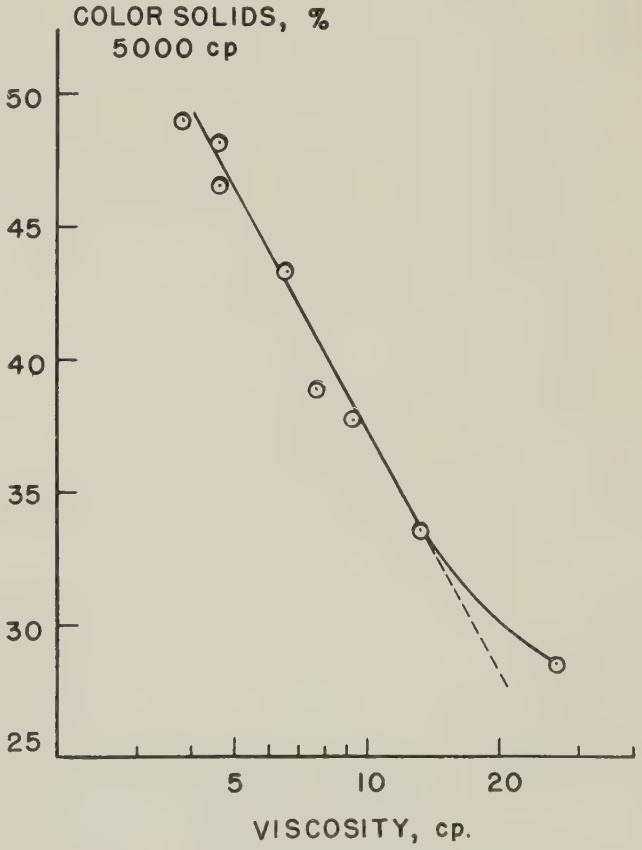

Fig. 9. Color solids versus CMC viscosity

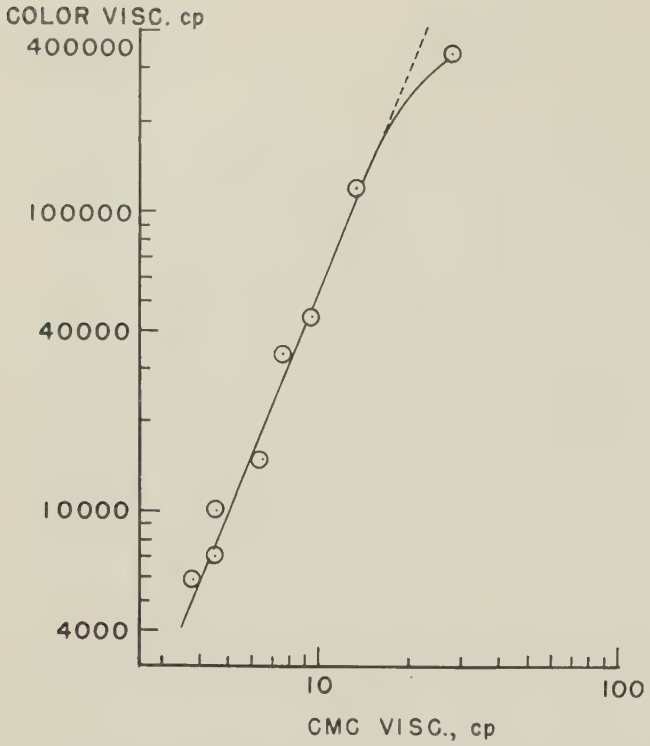

Fig. 10. Color viscosity versus CMC viscosity; color solids, 50%

these CMC's are shown in Fig. 8. Here the solids values range from approximately 28.5 to 49% at 5000 cp. color viscosity as the CMC viscosity drops from 27.4 to 3.8 cp.

Color solids values at a constant color viscosity of 5000 cp. were picked from the curves of Fig. 8. These values are plotted versus the CMC viscosities as Fig. 9. It is interesting to note that up to a CMC viscosity of about 13, the color solids vary linearly with the logarithm of the CMC viscosity. The color solids range covered by this linear portion of the curve is from about 33 to 50%.

The plot of color viscosity at constant color solids (50%) versus CMC viscosity is shown as Fig. 10. Here there is a direct linear relationship between the

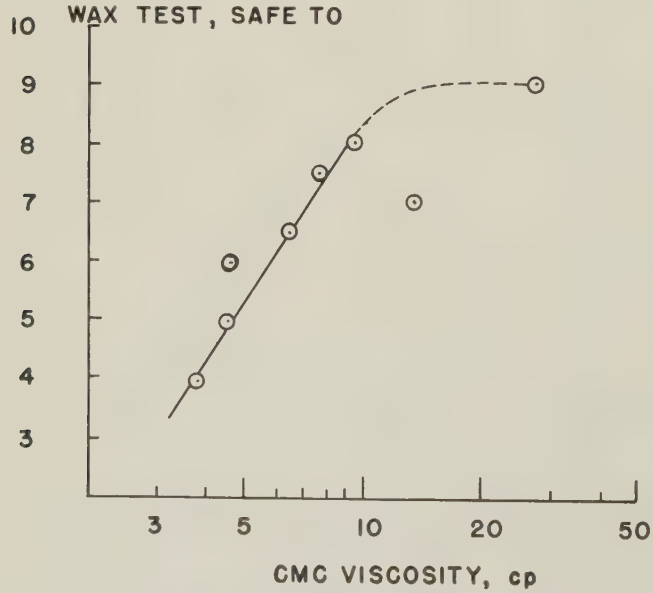

Fig. 11. Wax test versus CMC viscosity; 15% CMC on clay

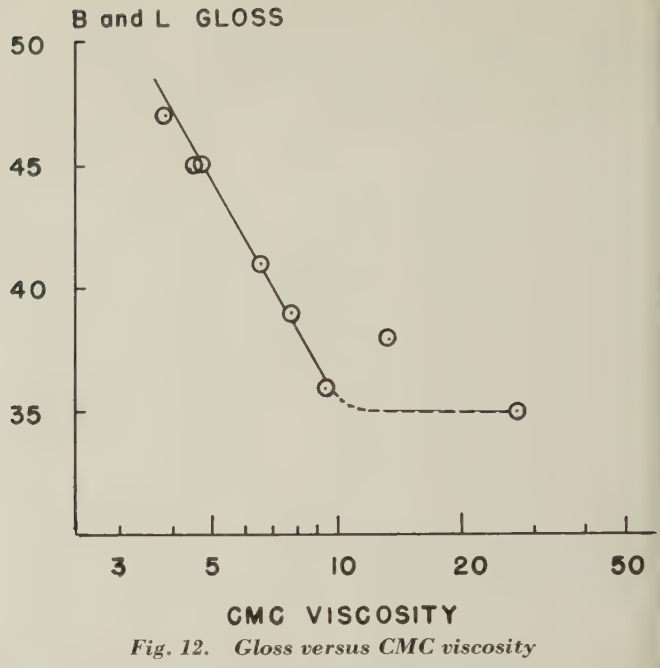

Fig. 12. Gloss versus CMC viscosity

viscosity of the two materials up to a CMC viscosity value of about 15.

As for the CMC samples mentioned previously, these samples gave color brightness and opacity values which were above those for starch colors. Both of these qualities appear to be unaffected by CMC viscosity. On the other hand, both wax test and gloss were sensitive to CMC viscosity. The wax test variation is shown as Fig. 11. This figure shows that wax test is approximately a linear function of the logarithm of CMC viscosity up to a value of approximately 10 cp. It also shows that the two thinnest CMC's gave wax tests below 6 and this is for 15% CMC on clay. In other words, the adhesive value for the CMC reduced this drastically in viscosity is poorer than the coating starch.

Figure 12 shows the relationship between B. & L. gloss and CMC viscosity. As for the wax test, B. & L. gloss varies linearly with the logarithm of CMC viscosity up to a value of about 10 cp. All these gloss values are lower than was obtained with the starch standard and if more adhesive were added to bring all colors up to a constant wax test, the drop in gloss for the low viscosity CMC colors would be even greater.

SUMMARY

Both the acid pretreatment and the alkaline aging methods gave significant control over the final CMC viscosity. The specific conditions used in the alkaline aging process were more drastic than those of the acid pretreatment and thus resulted in a lower viscosity range. In both cases viscosity reduction was obtained at the expense of adhesive strength. Again the more drastic conditions used in the alkaline aging resulted in greater adhesive strength loss for this method. In both methods, finish increase resulted from the reduction in CMC viscosity. Brightness and opacity were essentially unaffected by these treatments and were better in all cases than we normally expect from typical starch colors.

Presented at the Ninth Coating Conference of the Technical Association of the Pulp and Paper Industry, Bedford, Pa., May 14–16, 1958.

Correlation of the Sheffield Porosimeter and the Gurley Densometer

K. G. CHESLEY, E. D. JONES, and R. L. TRUAX

A Sheffield porosimeter and a Gurley Hill S-P-S tester were used to make porosity measurements on a group of paperboard samples selected to represent the normal range encountered in the manufacture of paperboard. A good correlation between the results from the two instruments was found. For testing boards with low permeability the Sheffield method is more rapid than the Gurley Hill.

IN THE manufacture of paperboard the two instruments used in this study are commonly employed to measure porosity or air resistance. A correlation of the results from these instruments should be of value.

The Sheffield porosimeter is designed to provide instantaneous measurement of the air resistance of paper and paperboard. Air at a definite pressure (10 p.s.i.) is conducted through passages from the base of the testing device to the lower gage head where a rubber ring acts as a seal against edge leakage. The rate of air flow through the paper is measured with a rotatometer-type gas flow meter. This gas flow meter measures the rate of air flow in cubic centimeters per minute through a 1-sq. in. section of the sample. The float in the flow meter reaches its position in the tube practically instantaneously regardless of the porosity of the board sample. Standard orifices are provided for calibration.

The Gurley Hill instrument measures the time required for 100 cc. of air to pass through 1 sq. in. of the test specimen. The sample is secured in a clamping device which prevents air leakage and air is forced downward through the test sample by an inverted cylinder floating freely in an outside cylinder partially filled with oil.

PROCEDURE AND RESULTS

A wide range of porosity was obtained by using samples of various calipers and furnishes. The calipers varied from 0.004 to 0.030 in. The furnish consisted of kraft pine, kraft hardwood and a mixture of kraft pine and kraft hardwood. A few of the samples selected also contained some groundwood.

The samples were cut into 3-in. squares and given an identification number. These were first tested on a Gurly Hill S-P-S tester which is basically a Gurley densometer equipped also to measure softness and smoothness. The surface covered by the anvil was marked and this marked surface was then tested on the Sheffield porosimeter. All tests were made by one operator and only one of each of the instruments was used. All tests were made under TAPPI Standard conditions of temperature and humidity.

K. G. CHESLEY, E. D. JONES and R. L. TRUAX, Research Division, The Crossett Co.

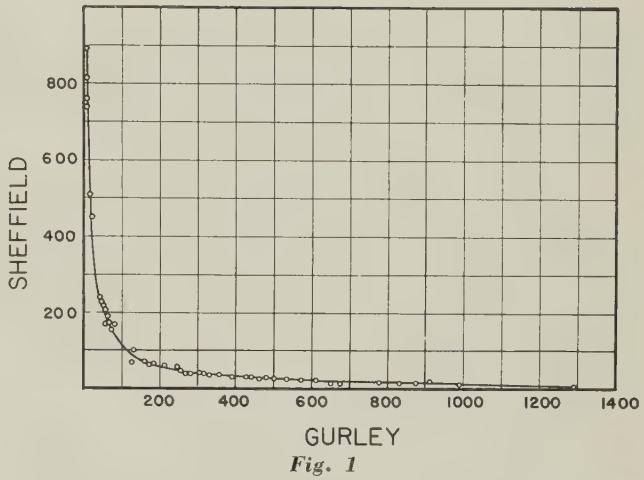

Fig. 1

The data from these tests are presented in Table I and are shown graphically in Fig. 1. It is obvious from Fig. 1 that a correlation does exist. A study of this curve indicated that a plot on log-log paper might give a straight line relationship. This was plotted and the relationship is shown in Fig. 2. It will be noted that when plotted using log-log scale a good straight line relationship results. The equation for this line is

$$\text{Log } Y = -1.16 \log X + 4.3393$$

A study of the data also indicated that the correlation of the instruments was better in the center of the range than at either end. To study these differences the data were divided into four groups. The difference between the actual Gurley porosity of each test and the

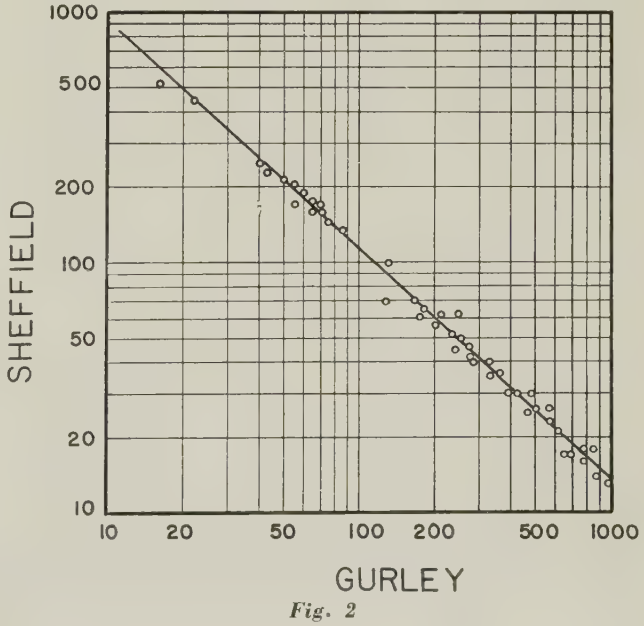

Fig. 2

Table I

Sample no.	Sheffield	Gurley	Sample no.	Sheffield	Gurley	Sample no.	Sheffield	Gurley
1	62	244	30	250	40	59	5)	245
2	35	330	31	135	85	60	58	244
3	40	313	32	17 '	73	61	41	338
4	41	306	33	40	281	62	40	331
5	50	250	34	70	163	63	31	427
6	205	57	35	68	168	64	31	440
7	190	61	36	65	162	65	57	202
8	175	65	37	62	174	66	68	204
9	160	71	38	450	22	67	13	990
10	170	68	39	510	16	68	18	780
11	100	128	40	17	650	69	14	876
12	170	55	41	815	7.6	70	6	1860
13	160	65	42	810	7.5	71	16	780
14	145	76	43	890	6.2	72	8	1288
15	200	54	44	890	6.2	73	18	840
16	50	242	45	760	7.7	74	17	675
17	172	67	46	740	7.8	75	18	828
18	150	66	47	900	6.2	76	16	652
19	185	54	48	890	6.0	77	20	905
20	215	50	49	23	534	78	26	570
21	70	127	50	29	480	79	21	610
22	64	182	51	25	467	80	45	268
23	45	241	52	26	497	81	26	480
24	50	243	53	52	235	82	36	357
25	46	240	54	39	321	83	42	277
26	48	240	55	42	264	84	48	244
27	182	55	56	42	275	85	45	272
28	165	57	57	30	390	86	50	243
29	230	43	58	62	208	87	43	280

Gurley value found by using the above regression equation was computed. This difference was used to compute the standard deviation of each group by using the following formula:

$$\sigma = \sqrt{\frac{\Sigma d^2}{n}}$$

The standard deviations found for each group are shown in Table II. From this table it is seen that within the range of 30 to 400 Gurley porosity the standard deviation between the observed and the calculated values is from 8 to 15% of the calculated values. At values of porosity below 30 and above 400 the variance between the observed and calculated values is greater.

It will be noted that the variance in the Gurley test is greater than in the Sheffield test, particularly in the high range of Gurley values. This is explained by the extremely long time involved in determining Gurley densometer values on dense board.*

Since the accuracy of the porosity determination can be increased by performing replicate determinations, a study of the error in each tester was made. The time required for each test was determined so that it may be considered when comparing the two instruments. The results of this study are given in Table III. These data show that, over the range studied, the 95% confidence interval expressed as a per cent

Table II

Range of Gurley porosity	n	Σd^2	σ	$\sigma/\bar{Y}$ %
1000–400	19	1,425,802	274	35
400–100	38	18,806	22	8
100–30	20	1,904	10	15
30–0	10	45	2	22

* It is known that the Gurley instrument used in this study was not designed for measuring porosities in this specific range. A high pressure model is made for measuring the porosity of less permeable sheets such as those used in this test. However, since the S-P-S tester is in general use for measuring porosities in the industry, this correlation is considered worthwhile.

Table III

	Sheffield	Gurley
No. of samples	12	12
No of replicate tests on each sample	16	2
Total testing time	24 min.	3 hr. 35 min.
Mean	52.4	538
Standard deviation	3.5	86
95% confidence limits	±7	±172
95% C. L. as % of mean	13.3%	32.0%

of the mean is ±13% for the Sheffield and ±32% for the Gurley. It should be pointed out that this variance in the Gurley tester will change with the density of the board being studied. Observation of the data indicates that the error is appreciably greater in the high range of Gurley values. Although the data thus far obtained are not complete enough to establish the testing variances accurately over the entire range, it is significant, that, over the ranges investigated in this paper, the variance of the Sheffield values are less than the Gurley. Of perhaps more importance, it is possible to run 16 replicate tests on the Sheffield in approximately 10% of the time required to run duplicates on the Gurley.

An analysis of the data obtained in this study has shown that the variation in smoothness of the board samples has not affected the results given herein.

SUMMARY AND CONCLUSIONS

In this study a correlation between the Gurley and Sheffield instruments has been established. The correlation can be stated mathematically by the equation $\text{Log } Y = 1.16 \log X + 4.3393$ where Y is the Gurley values and X is the Sheffield values. The variation in the Sheffield measurement can easily be reduced by running replicate determinations. This is not so readily done with the densometer because of the time required.

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Studies on the Lignin Fraction of Aspenwood Pulps Produced by Sulphite-Bisulphite Cooking Liquor Systems

DON E. MARTH

Aspenwood chips were pulped by sulphite-bisulphite cooking liquors of initial pH 4.5, 7.2, and 9.0, for varying lengths of time, under otherwise constant cooking conditions. The relationship between pulp yield, lignin content, sulphur content, aldehyde yield on nitrobenzene oxidation of pulp and liquor, and position of sulphonated and unsulphonated lignin residues in the partially cooked chips were compared for the various pH levels and pulping times.

THE neutral sulphite semichemical process (NSSC) has come into favor in the last few years largely because of its ability to produce competitive commercial pulps from deciduous wood. Since its development in 1926 (*1*), this process has been the subject of little fundamental work. Lea (*2*) studied the effect of a NSSC cook on the hemicellulose fraction of aspenwood, comparing the hemicellulose from the final pulp with the original wood hemicellulose. Quick (*3*) studied the nature and order of hemicelluloses removed during a NSSC cook of aspenwood. Doriswamy (*4*) investigated the kinetics of sodium sulphite pulping of aspenwood to determine the cooking conditions for maximum lignin removal and minimum pentosan removal.

The present work is presented as a contribution to knowledge of the fate of lignin in a neutral sulphite cook. Most of the hypotheses concerning sulphonation and removal of lignin cited in the literature (*5–13*) are only extensions of softwood acid sulphite pulping theory, but Husband (*14–16*) and Strapp (*17*) have reported basic work on the pulping of hardwoods in the sulphite-bisulphite range of liquor pH, varying liquor concentration, amount of buffer, pH, wood species, and time of pulping; the effect of changes in these cooking conditions on the chemical and physical properties of the resultant pulps provides insight into the differences between acid sulphite and neutral sulphite pulping.

In the present work, the following broad areas were investigated at liquor pH levels within the sulphite-bisulphite range, so that comparisons of the results in each area could be translated into additional knowledge of the differences in the reaction between lignin and sulphite cooking liquor at different pH levels:

1. The rate and extent of sulphonation of lignin.
2. The rate and extent of removal of lignin and total woody material.
3. The selectivity of the cooking liquor for lignin.
4. The homogeneity of lignin with respect to structural groups.
5. The path of liquor movement and reaction within the cell structure.

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SAMPLE PREPARATION

In order to provide pulp and liquor samples for analysis, an aspenwood (*Populus tremuloides*) log (45 yr. old, 6.85 rings/in., specific gravity 0.511 g. o.d./ml.) was veneered to a wet thickness of 0.097 in.; the veneer was air dried and cut into half-inch squares. Liquor was produced by the addition of gaseous sulphur dioxide to 1.25*N* solutions of sodium hydroxide until the desired pH level was attained; no additional buffer was added. Cooks were made at three levels of initial liquor pH; at pH 4.5, most of the sulphur dioxide was found to be present as bisulphite, while at pH 9.0, sulphite was the major component. Thirty-one cooks of varying total time were produced in stainless steel bombs of 200-ml. capacity in an electrically heated rocking jacket, according to the following schedule: time to temperature, 90 min.; time at temperature (170°C.), 120 min. for a complete cook. The charge was 150 ml. liquor and 15 g. aspenwood veneer squares (liquor/wood ratio = 10/1). Samples were withdrawn at 30, 60, 90, 150, or 210 min.

Four series of cooks were produced, distinguished by slight differences in rate of temperature rise at the beginning of the cook. These cooks are designated in general by the prefix "C," followed by the series number (I, II, etc.), followed by the intial liquor pH (4.5, 7.2, 9.0), and finally by the time of pulping in minutes (30, 60, etc.). The white and spent liquor analyses for each of the cooks may be seen in Table I. The series II cooks were repeat runs on some of the series I cooks; the series III cooks were all made at pH 9.0 for times longer than 210 min.; the series IV cooks were made with more complete analysis of resultant fractions and more precise temperature control during the early portion of the cook, assuring a uniform rate of temperature rise for any two cooks of equal pulping time. After pulping, each of the pulps was washed, disintegrated in a Waring Blendor, dried, disintegrated in a Micro-Wiley mill, and redried. The series, I, II, and III pulps were oven dried, and were not extracted prior to analysis; the series IV pulps were air dried, and were extracted with alcohol-benzene according to TAPPI Standard T 12 m-45 prior to analysis.

ANALYSIS

Lignin determinations were run on each of the pulps according to the following modified Klason procedure: 1 g. (o.d. or o.d. equivalent) of pulp was treated with 72% H_2SO_4 for 3.5 hr. at 18 to 22°C. The reaction mixture was then diluted to 800 ml., boiled for 4 hr. and filtered through two tared sheets of Whatman no. 42 filter paper. After washing free of acidity and sulphate ion, the papers were separated, dried at 105°C. overnight, cooled, and the weight of lignin

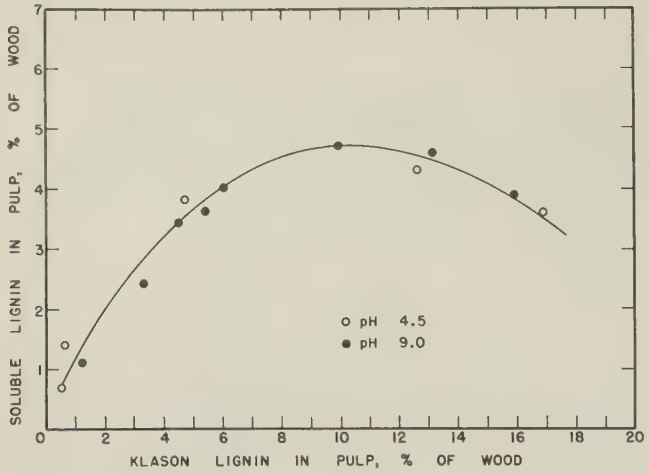

Fig. 1. Relationship between Klason and UV-soluble lignin content, series IV pulps

was determined as the difference between the weights of the sheets before and after filtration.

Soluble lignin determinations were run on the series IV Klason lignin filtrates only, by measuring the ultraviolet (UV) absorbance of the whole Klason lignin filtrate at 280 mmu (*18*), and converting to weight of lignin using the specific extinction data given by Buchanan, Brauns, and Leaf (*19*). It was found that the interference usually attributed to carbohydrate degradation products in the Klason lignin filtrate was increased by refluxing instead of boiling the filtrate, but the absorbance of a steam-distilled filtrate (which would be expected to be free of furfural, etc.) was no lower than that of a filtrate subjected to the normal boil in an open beaker. An ion-exchange method of soluble lignin determination proposed by McKenzie, McPherson, and Stewart (*20*) gave results in the same range as those obtained by UV measurement, but the alcohol blank values were found to be greater and more variable than those reported, making precise determination by this method difficult. Since soluble lignin determinations were not run on the first three series of cooks, it is necessary in certain cases to compare data on the basis of Klason lignin values alone. Figure 1, a plot of Klason lignin versus soluble lignin for the series IV pulps, shows, however, that under the pulping conditions and by the analytical procedures used in this work the amount of soluble lignin produced in pulps of any given Klason lignin content is the same for cooks of initial liquor pH 4.5 or 9.0. Therefore, comparisons based on Klason lignin data alone which do not indicate a difference that can be attributed to pH level, may also be expected to hold similarly for total lignin at either of these experimental pH levels. It is interesting to note that the ion-exchange soluble lignin data did not indicate the rise in soluble lignin content seen in the middle Klason lignin ranges in Fig. 1. This rise may be due to interference from carbohydrate material, which may be minimized in the ion-exchange technique.

The sulphur content of each pulp was determined by iodimetric titration of the sulphur dioxide liberated on burning of the sample in a Leco furnace. A portion of the great excess of sulphuric acid used in the Klason lignin procedure remained sorbed on the lignin residue, even after exhaustive washing. This retention was shown by the variability of sulphur content in isolated pulp Klason lignin residues with change in degree of washing, and by the sulphur found to be present in wood Klason lignin residues. A sulphur determination on Klason lignin residues is useless as a measure of the total sulphur content of all of the lignin in the pulp, both because of this sorbed sulphuric acid, and because a great portion of the sulphonated lignin may enter the filtrate during a Klason lignin determination, due to the solubilizing effect of the sulphonic acid radical. The sulphur content of all of the lignin as it exists in the pulp is estimated here as the quotient of the sulphur content of the pulp divided by the lignin content of the pulp. The sulphur content of the Klason lignin residue was found to be lower in each case than the calculated sulphur content of the whole lignin, indicating that the soluble lignin contains a major portion of the sulphur originally combined with pulp lignin.

Alkaline nitrobenzene oxidations were run on all four series of liquors and the series IV pulp according to the method of Stone and Blundell (*21*). It must be remembered that this technique is not a supplementary method of lignin determination, and does not show the total amount of guaiacyl and syringyl groups in any sample; rather, it indicates the number and ratio of those groups which are held by oxidizable bonds, and which may be converted to syringaldehyde and vanillin upon reaction with nitrobenzene.

A method of staining wood and pulp chip cross sections to observe the position of sulphonated and unsulphonated lignin at the end of each pulping interval was developed; wood or pulp chip longitudinal sections were cut on a freezing microtome to a thickness of 12

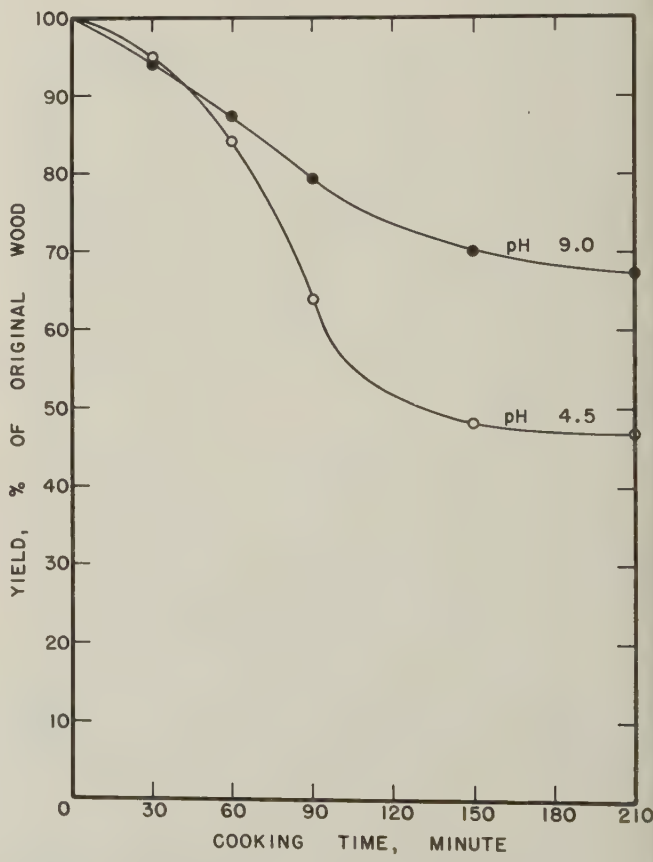

Fig. 2. Pulp yield versus time of pulping, series IV cooks

Table I. Pulping Data and Analyses for Series I–IV Pulps

Series no.	Initial liquor, pH	Total cooking time, min.	Total sodium as NaOH, g.p.l.	Total sulphur as SO_2, g.p.l.	Spent liquor, pH	Yield, % of o.d. wood	Extractives, % of unextr. wood	Klason lignin % of unextr. wood	Soluble lignin, % of unextr. wood	Total lignin, % of unextr. wood	Non-lignin/lignin ratio	Sulfur, % of pulp	Sulfur in pulp, % of pulp Klason lignin	Syringaldehyde yield, mg./ml. liquor	Vanillin yield, mg./ml. lignin	Molar S/V ratio in liquor	Syringaldehyde yield, % of pulp	Vanillin yield, % of pulp	Molar S/V ratio in pulp
Wood	...	...	...	...	...	100.0	3.01	17.6	3.2	20.8	4.7	0.0	0.0	...	...	...	6.12	2.56	1.99
CI	4.5	30	...	64.0	3.65	94.8	...	17.6	...	...	4.4	0.198	1.06	0.07	0.06	0.92	...	...	...
CII	4.5	30	50.2	73.2	4.51	95.6	...	16.5	...	...	4.8	0.172	1.00	0.04	0.04	0.76	...	...	...
CI	4.5	90	...	64.0	3.50	73.5	...	8.3	...	...	7.9	0.352	3.11	0.97	0.57	1.41	...	...	...
CI	4.5	150	...	64.0	3.41	54.6	...	2.2	...	...	23.4	0.243	5.91	2.84	1.31	1.80	...	...	...
CI	4.5	210	...	64.0	2.30	49.1	...	1.1	...	...	44.4	0.304	13.80	4.27	1.91	1.85	...	...	...
CII	4.5	210	50.2	73.2	3.02	54.8	...	1.1	...	...	51.6	0.177	9.30	3.54	1.64	1.80	...	...	...
CI	7.2	30	...	...	7.12	91.2	...	16.4	...	...	4.6	0.236	1.31	0.08	0.09	0.72	...	...	...
CII	7.2	30	50.2	42.7	6.89	93.1	...	15.7	...	...	4.9	0.188	1.11	0.05	0.06	0.77	...	...	...
CI	7.2	90	...	...	6.90	79.0	...	9.7	...	...	7.1	0.357	3.22	0.71	0.47	1.25	...	...	...
CI	7.2	150	...	...	6.90	73.0	...	6.6	...	...	10.1	0.377	4.18	1.54	0.80	1.60	...	...	...
CI	7.2	210	...	...	6.90	71.1	...	6.3	...	...	10.4	0.363	4.13	1.61	0.82	1.64	...	...	...
CII	7.2	210	50.2	42.7	6.70	73.8	...	7.0	...	...	9.5	0.408	4.29	1.74	0.92	1.58	...	...	...
CI	9.0	30	...	40.9	7.90	91.4	...	16.3	...	...	4.6	0.164	0.92	0.12	0.11	0.88	...	...	...
CII	9.0	30	52.2	35.5	7.90	91.8	...	15.0	...	...	4.9	0.161	0.95	0.07	0.07	0.85	...	...	...
CI	9.0	90	...	40.9	7.41	79.6	...	9.6	...	...	7.0	0.350	2.79	0.69	0.47	1.21	...	...	...
CI	9.0	150	...	40.9	7.49	70.3	...	5.6	...	...	11.5	0.326	4.07	1.77	1.03	1.43	...	...	...
CI	9.0	210	...	40.9	7.60	64.6	...	3.9	...	...	15.7	0.311	5.18	2.35	1.14	1.71	...	...	...
CII	9.0	210	50.2	35.5	7.29	75.1	...	7.1	...	...	9.5	0.295	3.10	1.73	0.88	1.64	...	...	...
CIII	9.0	360	50.0	37.8	7.20	69.2	...	5.4	3.6	9.0	11.8	0.332	4.26	...	...	...	...	...	...
CIII	9.0	480	50.0	37.8	7.20	64.1	...	3.3	2.4	5.7	18.2	0.253	4.86	...	...	...	...	...	...
CIII	9.0	600	50.0	37.8	7.10	56.8	...	1.2	1.1	2.3	46.6	0.177	8.43	...	...	...	...	...	...
CIV	4.5	30	50.1	75.3	3.90	95.0	1.48	16.7	3.6	20.3	4.6	0.089	0.50	0.03	0.03	0.83	6.54	2.74	1.99
CIV	4.5	60	50.1	76.0	3.42	84.0	0.68	12.5	4.3	16.8	5.7	0.302	2.01	0.35	0.24	1.21	5.13	2.29	1.86
CIV	4.5	90	50.1	75.3	3.15	64.1	0.46	4.7	3.8	8.4	11.9	0.305	4.18	2.01	1.05	1.59	2.74	1.29	1.76
CIV	4.5	150	50.1	75.3	3.00	48.0	0.54	0.6	1.4	2.0	75.9	0.151	11.61	3.60	1.70	1.75	0.45	0.24	1.55
CIV	4.5	210	50.1	76.0	2.67	46.8	0.82	0.5	0.6	1.1	99.0	0.318	31.80	4.33	1.97	1.83	0.39	0.23	1.40
CIV	9.0	30	50.1	38.7	7.60	94.0	0.93	15.7	3.9	19.6	4.9	0.127	0.75	0.11	0.12	0.80	6.09	2.58	1.96
CIV	9.0	60	50.1	39.5	7.17	87.3	0.45	13.0	4.6	17.6	5.7	0.285	1.90	0.40	0.32	1.05	5.14	2.32	1.84
CIV	9.0	90	50.1	37.8	7.03	79.3	0.28	9.9	4.7	14.6	7.0	0.362	2.90	0.82	0.54	1.26	4.49	2.05	1.82
CIV	9.0	150	50.1	37.8	7.05	70.1	0.35	6.0	4.0	10.0	10.6	0.360	4.18	1.67	0.91	1.52	3.13	1.49	1.74
CIV	9.0	210	50.1	39.5	7.12	67.2	0.36	4.5	3.4	7.9	13.9	0.319	4.76	2.38	1.17	1.69	2.37	1.22	1.61

to 20 mu, depending on the stiffness of the sample. These sections were placed on a microscope slide, straightened, and stained with *p,p'*-azodimethylaniline (PP') (saturated solution of dye in 30 parts acetic acid and 70 parts water) or malachite green (MG) (0.0075% dye in 30 parts water and 70 parts ethanol) for 30 sec., drained, washed in fresh water, and viewed under the microscope. PP' stains only those areas containing sulphonated lignin (*22, 23*), while MG stains areas of total lignification (*23*).

The results of the analysis of each of the 31 cooks may be seen in Table I.

REACTION RATE AND SELECTIVITY

The rate of reaction was found to be greater in cooks of initial liquor pH 4.5 than in those at pH 7.2 or 9.0; in most cases, analysis of the pulping products from the pH 7.2 cooks yielded data which were not appreciably different from those obtained from the pH 9.0 cook products. Figure 2 shows the difference in rate of removal of total woody material in cooks of different pH; the yield was lower at any given time greater than 40 min. in the bisulphite cooks than in the neutral sulphite cooks. The rate of delignification was also greater at pH 4.5, as seen in Fig. 3, Klason and total lignin content in the pulp versus time of pulping. These curves agree with the results of Husband (*15*) and Strapp (*17*), who present evidence indicating that the rate of sulphite reaction is greater in acid pH ranges than in the neutral or alkaline pH range. Figure 3 also effectively shows the increased importance of the soluble lignin factor at low lignin contents; in general, as the cooks progressed, the ratio of soluble lignin to total lignin in the pulp increased almost linearly through 210 min. cooking time (see Table I).

Figure 4, the nonlignin/lignin ratio in pulp versus yield, indicates that this ratio was greater at any given yield for pH 7.2 and 9.0 pulps than for pH 4.5 pulps; that is, although the rate of reaction was greater at pH 4.5, the selectivity of the liquor for lignin in pulping to a given yield was greater at pH 7.2 or 9.0. A plot of lignin content versus yield indicates the same result; the lignin content was greater at any given yield for pulps produced at pH 4.5 than those produced at pH 7.2 or 9.0.

SULPHONATION AND HYDROLYSIS

It may be seen in the tabular data that, in general, the sulphur content of each pulp rose to a maximum at about 90 min. cooking time, and decreased thereafter; the sulphur contents of the pH 4.5 pulps decreased most rapidly, followed by those at pH 9.0 and 7.2. The lignin content of these pulps, however, decreased even faster; the tabular data also show that the calculated sulphur content of the lignin in the pulps produced at pH 9.0 rose to a maximum, and then levelled off through 210 min. cooking time, while that of the pulps produced at pH 4.5 rose steadily throughout the cook. At cooking times longer than 210 min., the sulphur content of the pH 9.0 pulp lignins also rose, much as that of the pH 4.5 lignins.

According to one theory of sulphite pulping (*5, 6, 9, 10*), both "A" and "B" lignin groups may be sulphonated and removed by acid sulphite liquors, but lignin may be sulphonated only to the capacity of its "A" lignin groups by neutral sulphite liquors; "B" groups must be cleaved by acid hydrolysis and enter solution before they may be sulphonated. The data cited above indicate that the sulphonation of lignin in the solid state continued throughout the cook at all experimental pH levels of pulping, but at a slightly slower rate at pH 9.0 than at pH 4.5; also, the series III data show that it was possible to remove almost all of the lignin originally present in aspenwood by neutral sulphite pulping liquors.

A rearrangement of the data to more suitable bases for comparison yields evidence supporting the hypothesis that the same reactions of sulphonation and lignin removal which govern delignification at low pH also occur in the neutral sulphite range. Figure 5 shows a plot of calculated per cent sulphur in the pulp lignin versus the percentage of the original lignin which remains in the pulp. Data from all four series of pulping experiments fall well on this curve; for any given amount of delignification, the sulphur content of the lignin remaining in the pulp was the same for cooks at any experimental pH level of pulping. The sharp increase in sulphur content at low lignin contents may be drawn as another straight line intersecting the first, indicating that two sulphonation reactions may have occurred in the solid state in both sulphite and bisulphite cooks. All of the lignin appears to have been available for sulphonation in the solid state and removal by liquors at any of the experimental pH levels. The amount of sulphonation necessary to produce a given amount of delignification was the same for both bisulphite and neutral sulphite cooks, even at very low lignin contents. Therefore, the rate, but not the extent, of sulphonation and delignification appeared to vary with pH. If acid hydrolysis is the mechanism of lignin removal, it occurred in solutions whose room temperature pH did not drop below neutrality; it is possible that the local pH at certain points within the pulp chips dropped into the acid pH range, or that a pH shift occurred at the high temperatures and pressures of pulping. No attempt was made at pH evaluation during the cook.

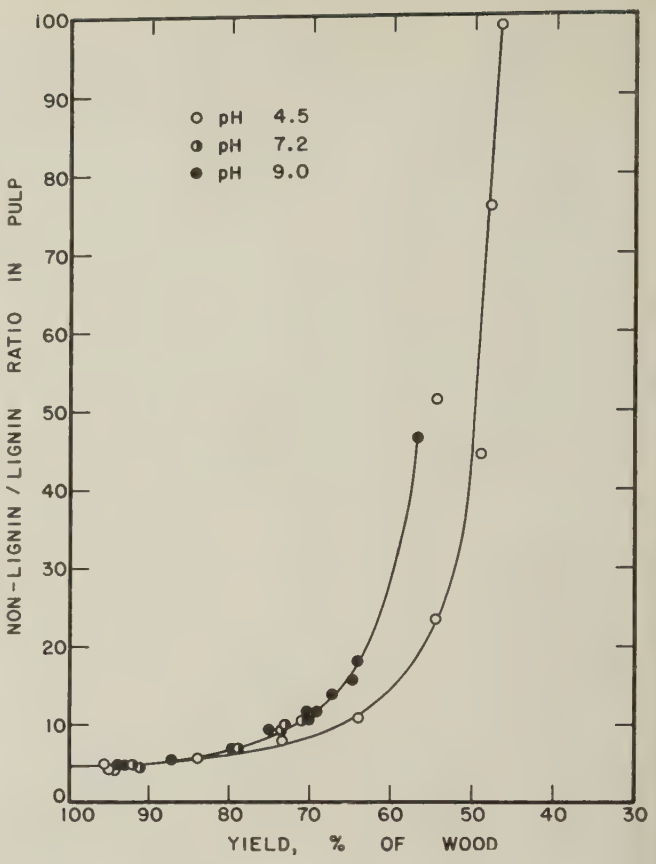

Fig. 4. Relationship between nonlignin/lignin ratio and yield, series I–IV pulps

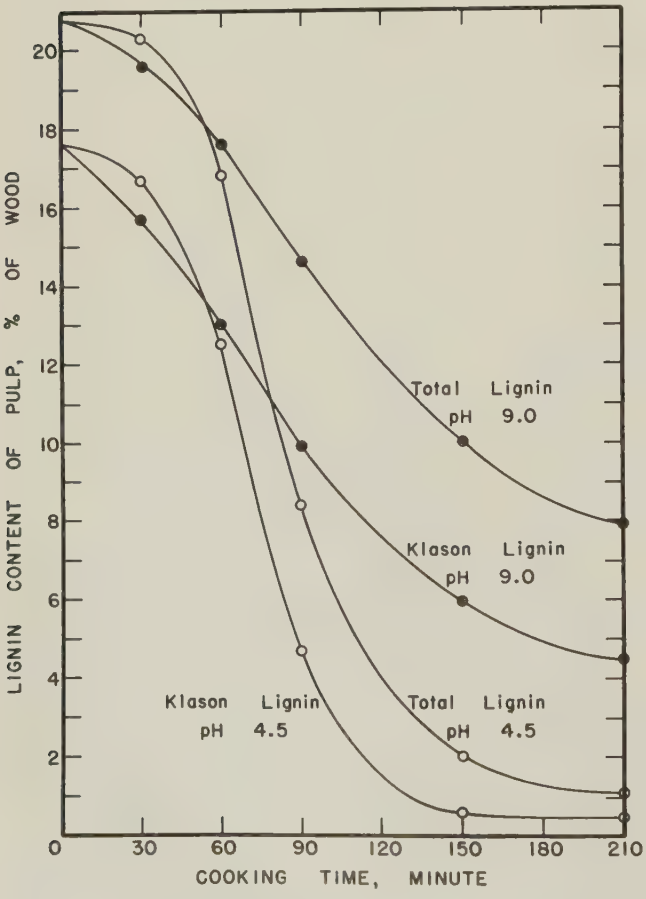
LIGNIN CONTENT OF PULP, % OF WOOD
COOKING TIME, MINUTE
Total Lignin pH 9.0
Klason Lignin pH 9.0
Klason Lignin pH 4.5
Total Lignin pH 4.5

Fig. 3. Lignin content of pulp versus time of pulping, series IV cooks

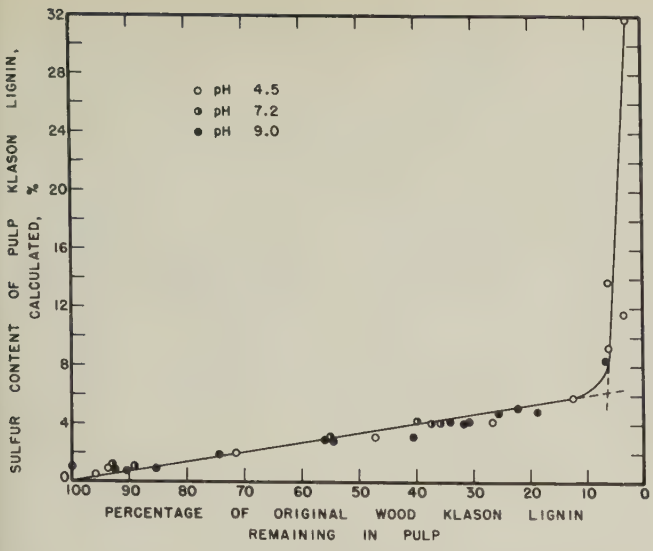
SULFUR CONTENT OF PULP KLASON LIGNIN, CALCULATED, %
o pH 4.5
pH 7.2
• pH 9.0
PERCENTAGE OF ORIGINAL WOOD KLASON LIGNIN REMAINING IN PULP

Fig. 5. Relationship between sulphur content of pulp lignin and amount of original wood lignin remaining in pulp, series I–IV cooks

GUAIACYL AND SYRINGYL GROUPS

It may be seen in the tabular data that the aldehyde yield on nitrobenzene oxidation of spent liquor samples (milligrams per milliliter liquor) increased at a faster rate in the cooks at pH 4.5 than in those at pH 7.2 or 9.0, in parallel with the differences in the rate of lignin removal at these pH levels. The aldehyde yield on oxidation of the pH 4.5 pulps likewise decreased faster than in those at pH 7.2 or 9.0. If the syringaldehyde yield is calculated on the basis of the lignin which had entered the liquor, this value increases with time during the cook for both pH levels of pulping, but the vanillin yield remains fairly constant at pH 4.5 and decreases slightly at pH 9.0. The calculated syringaldehyde "content" of the liquor lignin could not be extrapolated back to zero at zero cooking time, in disagreement with experiments reported in the literature (*24*). The syringaldehyde yield based on the pulp lignin content decreased at both pH levels, while the vanillin yield also decreased slightly, probably due to recovery loss of aldehyde with increased time and severity of reaction. It is apparent from the great variation found in ratio and amount of guaiacyl and syringyl groups in isolated pulp and liquor fractions that the pulping reaction served to fractionate these nuclei; the lignins solubilized in the early stages of a cook at either pH 4.5 or 9.0 were deficient in syringaldehyde yield on nitrobenzene oxidation, while the vanillin yield from lignins isolated at any time during a cook was seen to remain fairly constant. The ratio of syringaldehyde to vanillin versus pulping time may be seen for both spent liquors and pulps in Fig. 6; the ratio increased from about 0.5 to almost 2 in the liquor at both pH levels, but at a slightly faster initial rate in the pH 4.5 liquors. The ratio likewise decreased in the pulps, and at a slightly faster rate at pH 4.5. These curves confirm the evidence presented above that, although the syringaldehyde yield on oxidation of spent liquors was not zero at the beginning of the cook, the first lignin fractions to enter the liquor were probably deficient in syringyl yield, when compared to the over-all ratio of syringly to guaiacyl in aspenwood.

The per cent vanillin and the per cent syringaldehyde calculated on the basis of the liquor lignin and the pulp lignin (Fig. 7), and the syringaldehyde/vanillin ratio in the liquor and the pulp (Fig. 8), were found to be the same at any given degree of delignification for cooks at any pH within the range of these experiments. It has been noted above that the amount of sulphonation required to produce a given amount of delignification was the same in bisulphite or neutral sulphite pulping liquors; similarly, the amount and ratio of guaiacyl and syringyl-type lignin groups (which yield vanillin and syringaldehyde, respectively, on nitrobenzene oxidation) was also the same in both the pulp and the liquor, in bisulphite or neutral sulphite cooks. This adds support to the hypothesis that the same general reactions which govern the removal of lignin in bisulphite liquors may apply as well in neutral sulphite liquors, not only in the sulphonation and removal of reactive groups, but also in the removal of structural groups.

MICROSCOPIC EXAMINATION

Representative chip samples from each of the series IV pulps were sectioned and stained with malachite green (MG) and *p,p'*-azodimethylaniline (PP'). Wood chips stained rather uniformly green with MG and did not stain to any extent with PP'.

Thirty-minute pulp chips stained with MG appeared almost identical to stained wood chip sections, but PP' gave a red coloration in the corners of the middle lamella, and to a lesser degree in the vessel and ray cell walls. At 90 min., the middle lamella, vessel and ray cell walls still stained quite dark green with MG, but a color gradation was apparent in the cell wall, with the outside of the cell almost as dark green

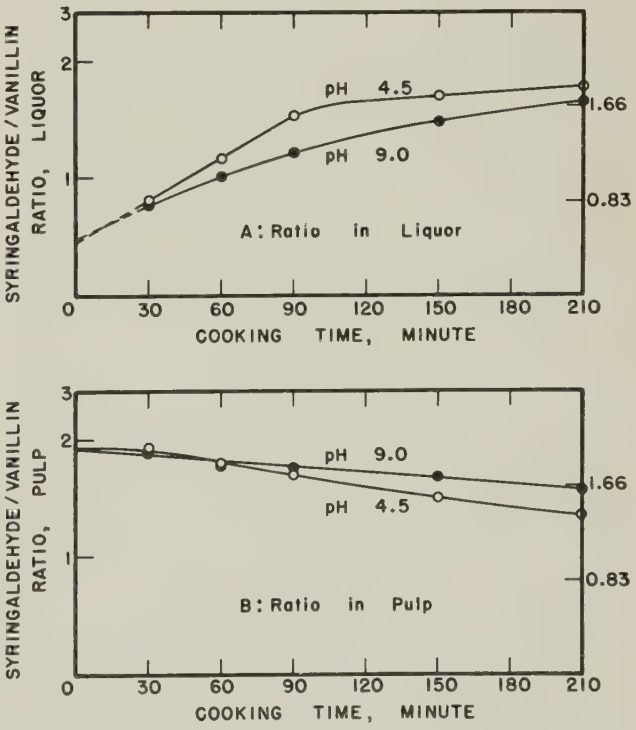

Fig. 6. Syringaldehyde/vanillin ratio on nitrobenzene oxidation of liquor and pulp versus time of pulping, series IV cooks

as the middle lamella, and the portion nearest the lumen much lighter green. The pH 9.0 pulp was whiter at the lumen, but the gradation was sharper in the pH 4.5 pulp. PP′ stained the middle lamella to a much greater color intensity than at 30 min., and the outside of the cell wall showed some red coloration, especially in the pH 4.5 pulp. At 150 min., the middle lamella at pH 4.5 was almost gone, due to the drastic reduction of over-all lignin content, and the cell wall was partially destroyed; however, the middle lamella remained stained dark green with MG, while the cell wall appeared very light green. At 210 min., the pulp produced at pH 4.5 contained very little middle lamella, and the cell wall stained a mottled green-white. At 210 min. at pH 9.0, however, the cell structure was still intact; the middle lamella, vessel and ray cell walls still stained dark green. The cell-wall color gradation was much sharper than at 90 min., with the portion of the wall nearest the lumen almost pure white; the outer portion of the cell wall was lighter than pulp CIV 9.0-90. PP′ stained the cell wall of pulp CIV 4.5-150 a uniform light pink, and that of pulp CIV 4.5-210 gave virtually no color with PP′. The middle lamella of pulp CIV 9.0-210 was almost as red as pulp CIV 9.0-90, while the cell wall stained much redder around the outside.

In summary, MG stained the whole cell wall and middle lamella in wood and in the pulps of short total

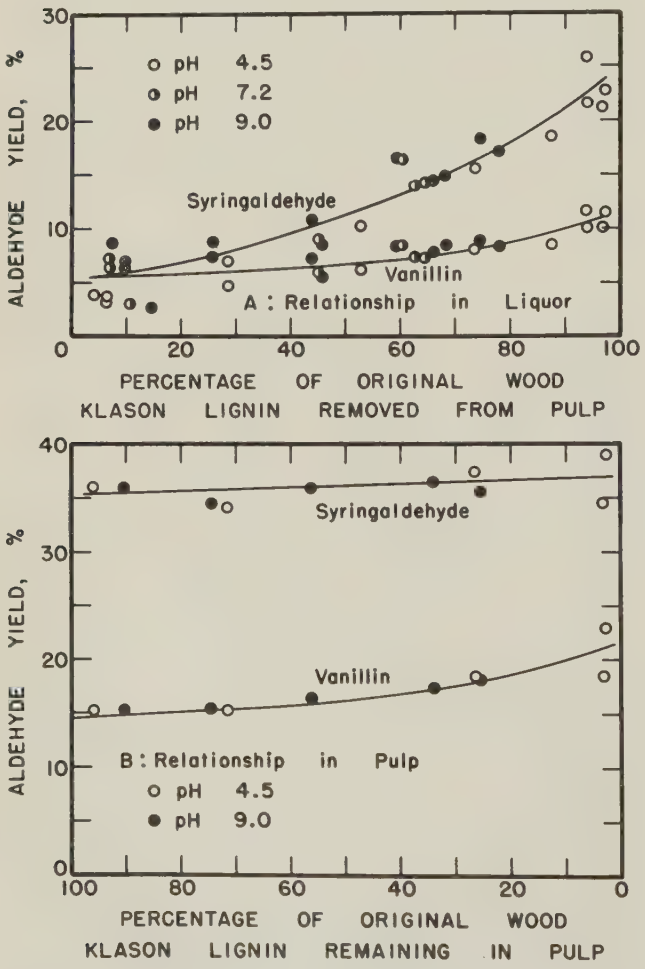

Fig. 7. Relationship between aldehyde yield on nitrobenzene oxidation based on lignin in (A) liquor and (B) pulp and amount of original wood lignin present, series I–IV cooks

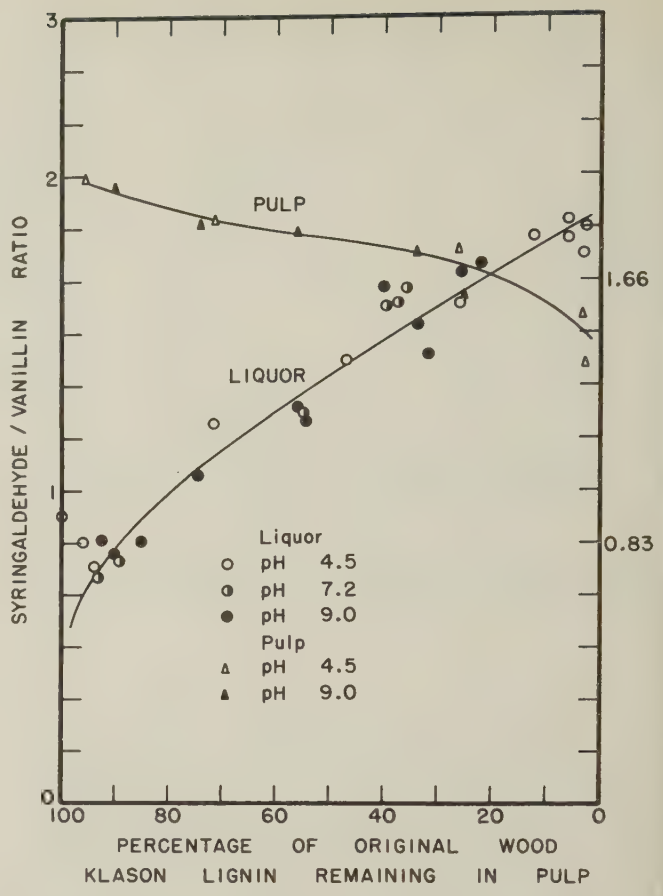

Fig. 8. Relationship between syringaldehyde/vanillin ratio in nitrobenzene oxidation of liquor and pulp and amount of original wood lignin present, series I–IV cooks

cooking time; as the cooks progressed, only the middle lamella and outer cell wall continued to give coloration with this dye. Just as the portion of the cell wall nearest the lumen ceased to stain green with MG toward the end of the cook, this area never gave a red coloration with PP′; the middle lamella was stained red especially in the corners between the cells at the beginning of the cook. This red color spread to the whole middle lamella in the middle of the cook, and decreased in intensity toward the end of the cook. The vessel and ray cell walls were stained a fairly uniform pink throughout the cook.

From these observations, it is possible to deduce the path of liquor movement within the cell structure during cooks at both pH 4.5 and 9.0; no differences in manner of penetration (or change in area of coloration) were observable for these two pH levels, but differences in rate coincided with the results of the analytical determinations on each pulp series. It appears that the removal of lignin (change in green coloration with MG) proceeded from the lumen outward toward the middle lamella, while the sulphonation of lignin (change in red coloration with PP') proceeded from the middle lamella inward toward the lumen. If this is the case, it is probable that a portion of the lignin nearest the lumen may have been removed without first being sulphonated.

Flow through vessel and ray cell pits to adjacent vessels and ray cells was probably the main means of liquor distribution within the chip; these cells were among the first to be sulphonated, although they

retained total and sulphonated lignin for most of the cook. This retention was probably due to the high concentration of lignin present, especially in the ray cells, and to the fact that liquor flow out of the vessels proceeded at least partially through pits, which would not be expected to allow a uniform removal of lignin over the whole cell wall.

Liquor probably penetrated the fibers mainly through cell-wall diffusion, due to the scarcity of fiber-fiber pitting in aspenwood. In this manner, the lignin in the middle lamella surrounding any fiber was encountered and sulphonated before the cell-wall lignin; the liquor then proceeded through the cell wall to the lumen, carrying with it either soluble lignin from the portion of the cell wall nearest the lumen, or lignin solubilized by means of the sulphonation reaction, which occurred mainly in the middle lamella in the early portion of the cook. From the lumen, it was necessary for the liquor to diffuse through the cell wall a second time to reach other middle lamellas and lumens. As the reaction proceeded, the area of delignification increased to encompass the whole cell, and finally the middle lamella; when this occurred, the fibers were freed from their incrusting lignin sheath.

An attempt was made to relate the preferential removal of different portions of the cell structure by pulping liquors at various times during the cook, as observed in the microscopic examination, to the fractionation of guaiacyl and syringyl groups in pulp and liquor fractions, as determined by nitrobenzene oxidation, in an attempt to characterize the homogeneity of distribution of these nuclei across the cell wall. Since the nitrobenzene oxidation of the Kullgren hydrolysis extract (mainly sulphonated lignin) of a 90-min. pulp produced at pH 9.0 indicated greater concentrations of syringaldehyde than vanillin, and since less change was apparent with increased cooking time in the ratio of syringaldehyde/sulphur than in that of vanillin/sulphur in the pulp, it is possible that the bulk of the combined sulphur present in the cooking liquor had preferentially united with syringyl, rather than guaiacyl nuclei. Nitrobenzene oxidation indicated a high vanillin yield from lignins removed during the early stages of the cook; microscopic examination showed that these fractions probably originated mainly in the cell wall, and were not necessarily sulphonated. In the latter portion of the cook, the more highly sulphonated middle lamella was removed; it has already been shown that the proportion of syringyl groups available for oxidation in the lignin in the liquor increased with increase in cooking time.

If the nitrobenzene oxidation procedure yields an accurate estimate of the true ratio of syringyl and guaiacyl groups present in the lignin fraction of a pulp or liquor sample, it is probable that these groups are not homogeneously distributed across the aspenwood cell wall. This possibility has already been advanced by Stone (*24*) and Aaltio and Roschier (*25*). The results cited above indicate that the ratio of syringyl groups to guaiacyl groups may be greater in the middle lamella lignin, which is first sulphonated during a sulphite-bisulphite cook of aspen, than in the cell-wall lignin, which tends to be removed in the early portion of such a cook.

CONCLUSIONS

1. The rate of reaction was found to be greater in bisulphite cooks of aspenwood than neutral sulphite cooks, with faster removal of total woody material and lignin, and faster sulphonation of pulp lignin, but the selectivity of the neutral sulphite liquor for lignin was found to be greater than that of bisulphite liquor.

2. The sulphur content of the lignin remaining in the pulp, the amount of soluble lignin produced during a Klason lignin determination, and the amount and ratio of syringaldehyde and vanillin liberated on nitrobenzene oxidation of both pulp and liquor samples, were found to be the same at any given degree of delignification for cooks at all experimental pH levels. The bulk of the lignin originally present in aspenwood was found to be removable by neutral sulphite pulping liquors as well as by bisulphite liquors. The same general reactions which govern the sulphonation and removal of reactive and structural groups in the bisulphite range of pulping appear to hold in the neutral sulphite range; only the rate of reaction was found to vary with pH.

3. Microscopic examination of stained pulp chip cross sections indicated that the area first sulphonated in a bisulphite or neutral sulphite cook of aspenwood was the middle lamella, while lignin in the cell wall was the first to be removed, possibly without first being sulphonated. Guaiacyl and syringyl nuclei are fractionated by pulping liquor, and may be heterogeneously distributed across the cell wall of aspenwood, with greater proportions of syringyl in the middle lamella and greater proportions of guaiacyl in the lignin within the cell wall.

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The Use of Peroxide after Chlorine Dioxide in Bleaching Kraft Pulp

A. F. CHADWICK, F. L. FENNELL, and H. E. WAGONER

The laboratory study of the use of an alkaline peroxide stage in bleaching kraft pulp to high brightnesses has led to the conclusion that the best process consists of the following five stages: chlorination, alkali extraction, hypochlorite bleach, chlorine dioxide bleach, and peroxide bleach. This sequence gives pulp with G. E. brightness in the range of 89 to 91%. Strength of the pulp is good and brightness stability is outstanding. The process has proved effective for all types of kraft pulp. Study of the variables in the peroxide stage has shown that retention time in the bleaching stage should be at least 2 to 3 hr., and preferably 4 hr., with the temperature at 170 to 185°F. As increasing consistency increases the rate of reaction, the consistency should be as high as possible. It is recommended that 2 to 3% $NaSiO_3$ be used. With this quantity of sodium silicate caustic soda requirements are not critical, 0.0 to 0.3% NaOH giving equivalent results. The brightness obtained is dependent on the quantity of peroxide used. However quantities above 0.25% H_2O_2 (100% basis) become increasingly less effective. Although stabilization with magnesium sulphate and sodium silicate is most effective, almost equivalent results have been obtained with a combination of magnesium sulphate, gluconic acid, and alkaline buffers.

Alkaline solutions of hydrogen peroxide have been used for many years for bleaching kraft pulp. The two major advantages of these peroxide solutions are: (1) pulp brightness is increased with very little cellulose degradation and (2) the brightness of the bleached pulp is more stable than that obtained from other bleaching agents.

The use of peroxides in multistage kraft bleaching processes has been studied in Du Pont laboratories for a number of years. It has been found that G.E. brightnesses in the 86 to 90% range can be obtained by a number of four, five, or six-stage processes in which a peroxide stage is used in addition to conventional chlorine, caustic, and hypochlorite treatments. The peroxide can be applied either as a final bleach or in an alkaline extraction stage which precedes a final hypochlorite bleach. Several processes of this type have already been described (*1*, *2*, *3*). In a large number of kraft bleaching processes which have been installed in recent years a major part of the brightness gain is obtained with chlorine dioxide. Since chlorine dioxide made it possible to obtain stronger and brighter pulps, the next logical step was to use chlorine dioxide and peroxide to obtain the advantages of both. In 1950 Casciani and Storin (*4*, *5*) showed that kraft pulp with excellent strength and brightness stability is obtained in the following five-stage sequence: chlorination, caustic extraction, hypochlorite bleaching, chlorine dioxide bleaching, and peroxide bleaching. Extensive work in the Du Pont laboratory has shown that this chlorine dioxide-peroxide sequence provides the best procedure available for obtaining high-brightness kraft pulp. Brightnesses of 89 to 91 can be obtained with essentially no strength loss as compared to the unbleached pulp. The brightness stability of the bleached pulp as measured by accelerated aging tests is outstanding in comparison with pulp from other bleaching processes. This process has been found equally advantageous for all types of kraft pulp regardless of wood species or geographical origin.

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EXPERIMENTAL PROCEDURES

The work described in this paper was carried out on a variety of kraft pulps obtained in the moist state from a number of mills in this country and Canada. The chlorine demand of the unbleached pulps was in the range of 7 to 11%. The following procedures were used for carrying out the bleaching stages:

Table I. Five-Stage ClO_2-H_2O_2 Process

Stage	*G.E. brightness, %*	*Viscosity, cp.*
Unbleached	24.2	24.8
1. Chlorination	26.5	18.8
2. Alkali extraction	32.1	18.9
3. Hypochlorite bleach	66.6	16.7
4. Chlorine dioxide bleach	84.5	16.6
5. Peroxide bleach	90.2	16.4

Notes:
Chlorine demand of southern pine kraft was 9.5%.
Bleaching Conditions:
Stage 1—5.2% Cl_2, 3% consistency, 45 min. at 70°F., 7% of Cl_2 was unreacted.
Stage 2—2.5% NaOH, 12% consistency, 1 hr. at 180°F.
Stage 3—1.0% Cl_2 as $Ca(OCl)_2$ (57% of demand), 12% consistency, 2.5 hr. at 95°F., pH range 11.2 to 10.4, 3% of Cl_2 unreacted.
Stage 4—0.6% ClO_2, 12% consistency, 3 hr. at 160°F., pH 3.5 at end of bleach, 19% of ClO_2 unreacted.
Stage 5—0.25% H_2O_2 (100%), 3% sodium silicate, 0.3% NaOH, and 0.05% Epsom salt. 12% consistency, 4 hr. at 180°F., pH range 10.4 to 9.2, 53% of H_2O_2 unreacted.

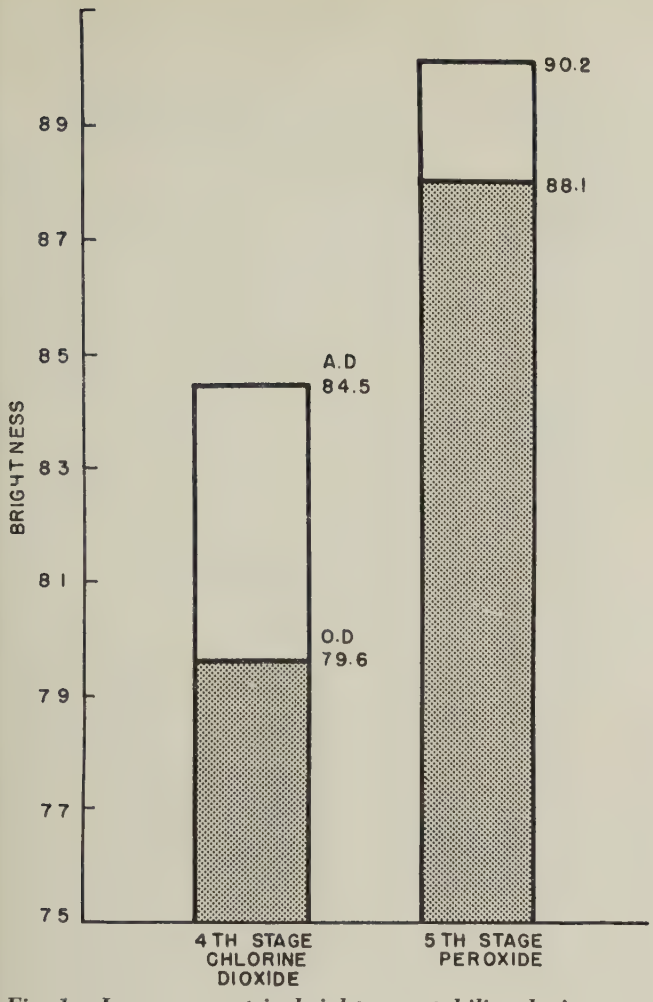

Fig. 1. Improvement in brightness stability during peroxide bleaching

Chlorination. The pulp was added to freshly prepared chlorine water containing the desired quantity of chlorine and sufficient water to give a consistency of 3.5%. For most pulps it was found best to use chlorine equal to 55% of the theoretical demand as determined by TAPPI Standard T 214. The pulp slurry was mixed thoroughly and allowed to react for 30 to 45 min. at about 75°F. Longer reaction times did not appear to improve purification of the pulp in this stage.

Alkali Extraction. The desired quantity of sodium hydroxide was added to sufficient water so that when mixed with the pulp the consistency would be 12%. After the caustic solution had been mixed in, the pulp was placed in a glass beaker in a water bath and heated at 180°F. for 1 hr.

Hypochlorite Bleach. A solution containing the desired quantity of chlorine, as either sodium or calcium hypochlorite, and the sodium hydroxide necessary for pH control was added to the pulp. The water was the correct quantity to give a consistency of 12%. The pulp was then put in a beaker and heated in a water bath at 95°F. for 2.5 hr.

Chlorine Dioxide Bleach. Chlorine dioxide was prepared by reaction of hypochlorous acid with 2 moles of chlorous acid. This was accomplished by pareparing a solution which contained 0.1 *M* NaCl and 0.05 *M* NaOCl and adding enough sulphuric acid to yield 0.1 *M* concentration. The chorine dioxide

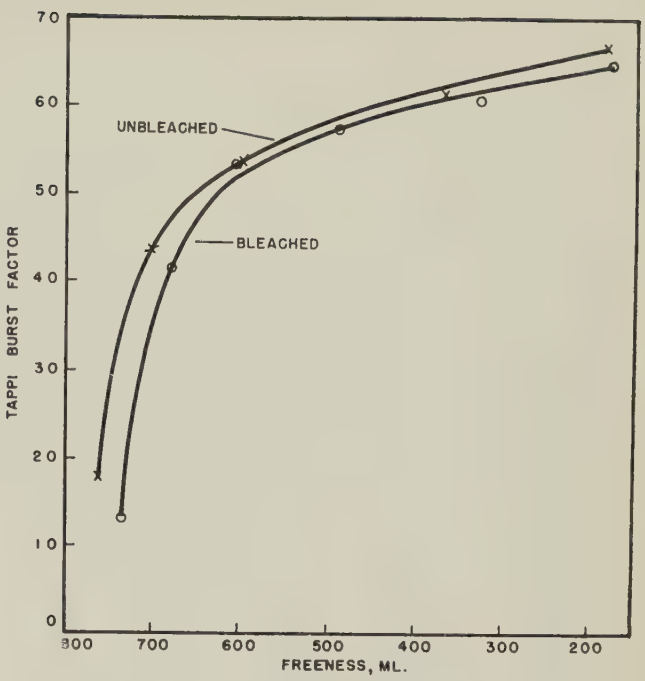

Fig. 2. Burst strength of pulp bleached with chlorine dioxide-peroxide process

was separated from the inorganic impurities by volatilizing with a stream of nitrogen and reabsorbing it in ice water. The resultant solution was free of chlorine.

The pulp was placed in a polyethylene bag and the chlorine dioxide solution plus enough water to provide a consistency of 10% were added. The bag was closed immediately and the contents mixed by kneading. To make sure there was no leakage of chlorine dioxide the bag was placed inside a second polyethylene bag. The sample was then immersed in a water bath at 160°F. for 3 hr.

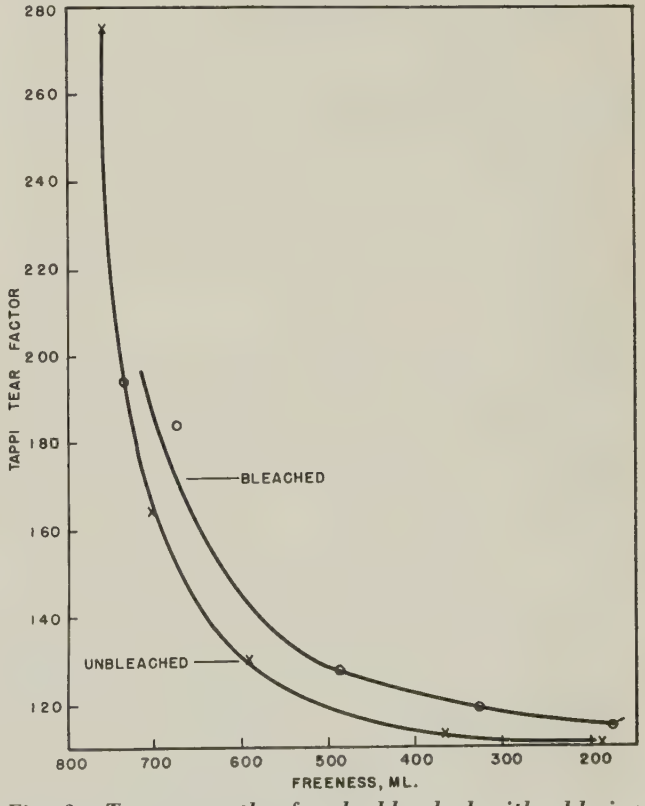

Fig. 3. Tear strength of pulp bleached with chlorine dioxide-peroxide process

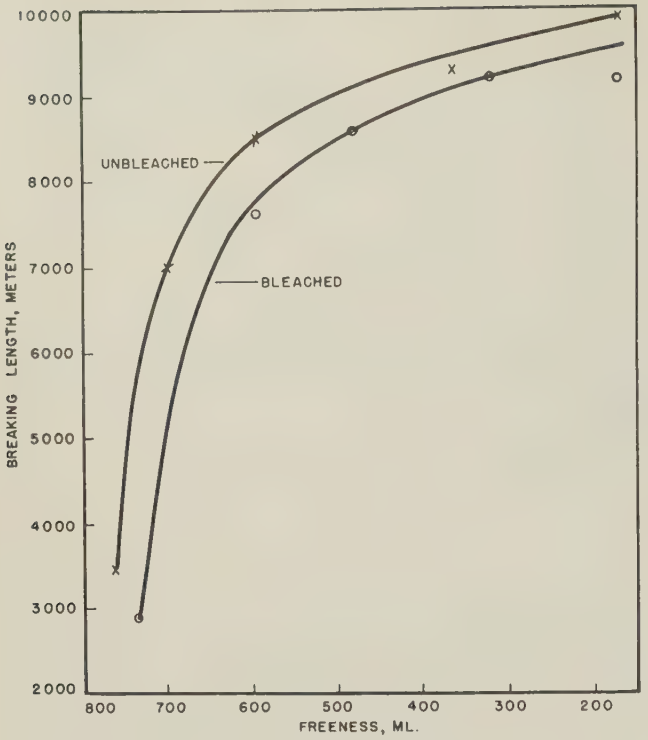

Fig. 4. Tensile strength of pulp bleached with chlorine dioxide-peroxide process

Peroxide Bleach. A stabilized bleach solution was prepared by adding to the water, in order, the desired quantities of magnesium sulphate (Epsom salt), sodium silicate (41°Bé.), sodium hydroxide, and hydrogen peroxide. Although hydrogen peroxide and sodium hydroxide were used in this work, the same results could have been obtained by using sodium peroxide and hydrogen peroxide to yield the same alkali and active oxygen concentrations.

The bleach solution and any extra water required to give 15% consistency were mixed with the pulp. The mixture was then heated in a water bath for 4 hr. at 180°F. except in those cases where other temperatures are noted.

Washing. The pulp was washed thoroughly after each stage with clear tap water.

Testing. Handsheets were prepared in a Valley sheet mold after adjusting the pH to 4.5 with dilute sulphuric acid.

Brightnesses were determined either with a G.E. brightness meter or with a Hunter Multipurpose Reflectometer which had been calibrated according to TAPPI RC258. The color stability of the bleached pulp was determined by heating a dry sheet in a forced draft oven for 1 hr. at 105°C. (221°F.) and then redetermining the brightness. This is referred to as oven-dry brightness.

Viscosity was determined for a 0.5% cellulose solution in 0.5 *M* cupriethylenediamine using viscosity pipets according to TAPPI Standard T 230.

The strength tests reported in this paper were carried out at the State University College of Forestry, Syracuse, N. Y. using TAPPI Standard tests T 200, T 205, T 220, and T 227.

Results with Five-Stage Chlorine Dioxide-Peroxide Process

The data for a typical bleach on southern pine kraft

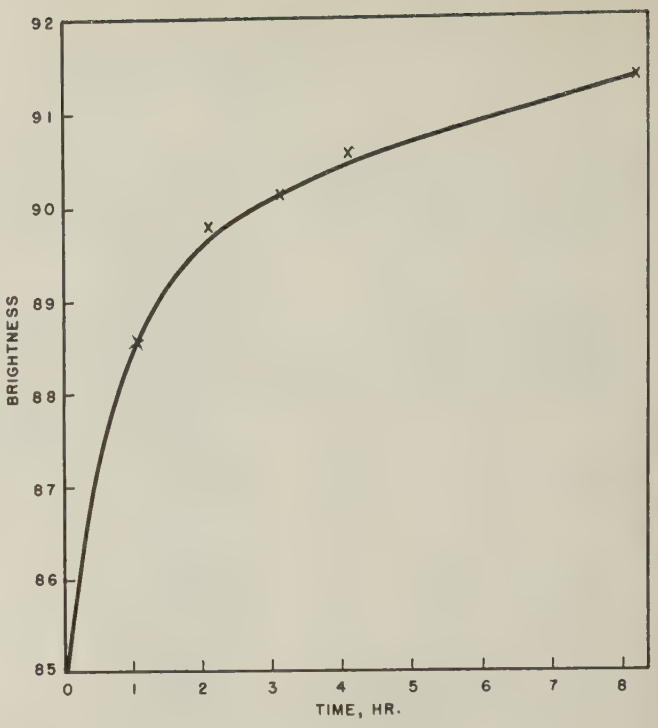

Fig. 5. Rate of brightness increase in peroxide stage

pulp with this process are shown in Table I. The final peroxide stage increased the G.E. brightness from 84.5% to 90.2%. Accelerated aging tests showed that the peroxide stage not only increased the pulp brightness but also improved the brightness stability. As shown in Fig. 1 the pulp reverted only 2 points after the peroxide stage as compared to the 5-point reversion of pulp from the chlorine dioxide stage. Strength data for this pulp are shown in Figs. 2 to 4.

To obtain the best results with this process, as much purification as possible should be carried out in the first two stages. The quantity of hypochlorite,

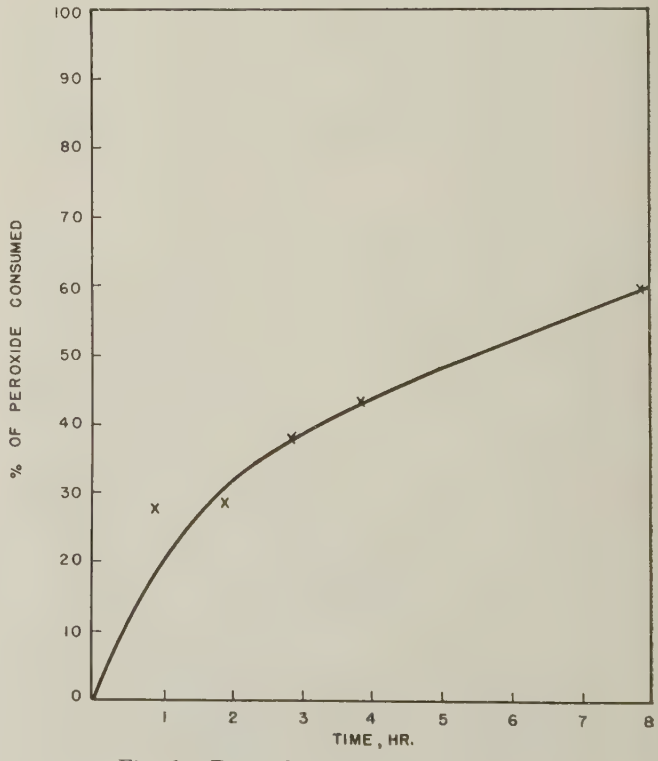

Fig. 6. Rate of peroxide consumption

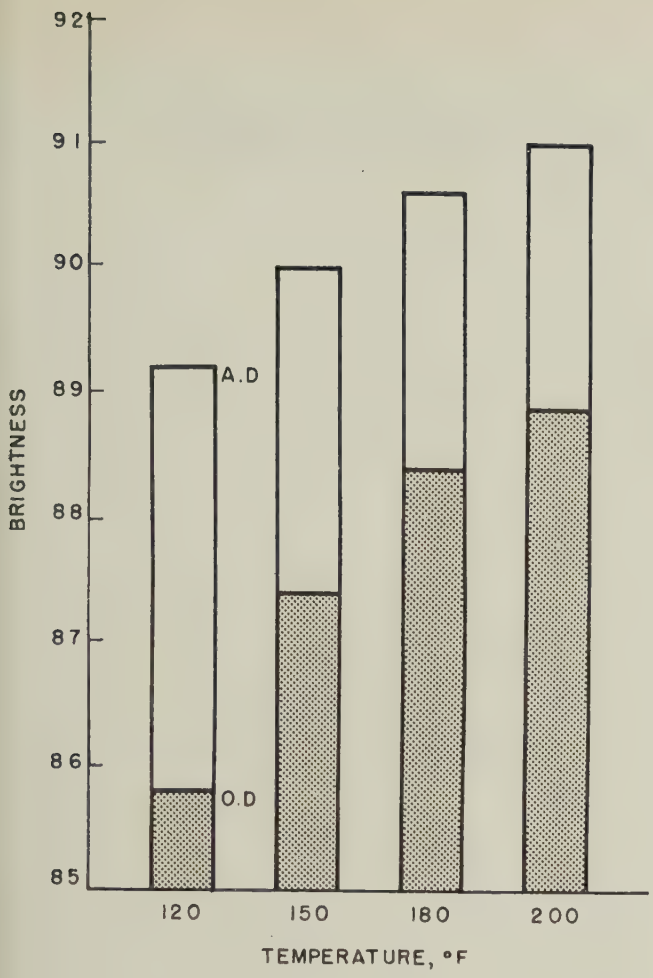

Fig. 7. Effect of temperature on brightness and stability

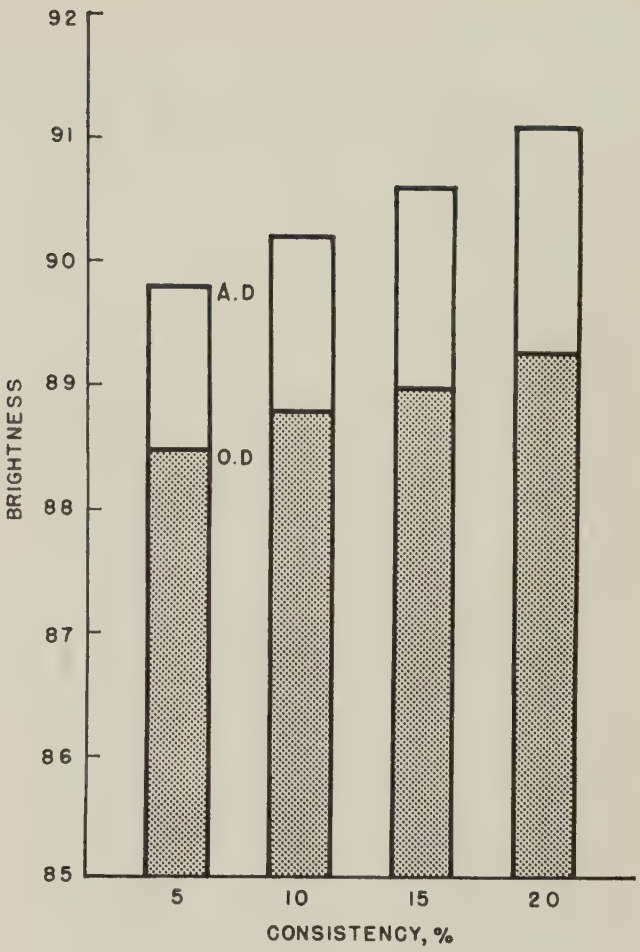

Fig. 8. Effect of consistency on peroxide bleach

either sodium or calcium hypochlorite, in the third stage should then be limited to that required to reach a brightness of about 65. It has been pointed out (*6*), that a single chlorine dioxide stage will raise the brightness of kraft pulp from 65% to about 85%.

Effect of Variables in Peroxide Bleaching Stage

The conditions shown in Table I for the peroxide stage were selected on the basis of economic and technical considerations from the data given in Figs. 5 to 11. In obtaining the data for these figures, one variable was changed at a time, while all other factors were kept constant.

Figure 5 shows the rate of brightness increase using the standard peroxide bleach. The increase in brightness is rapid during the first few hours and then becomes slower. This shows that a time of at least 3 hr., and preferably 4, should be used for this stage. Figure 6 shows that after 8 hr., 40% of the peroxide is unconsumed. It is for this reason that the brightness is still increasing after an 8-hr. storage period.

The effect of temperature on the peroxide stage is shown in Figure 7. In the standard 4-hr. reaction period, it is advantageous to use as high a temperature as possible. These data show that brightness stability is much better when high bleaching temperatures are used. In 1 hr. at 105°C., pulp bleached at 120°F. loses 3.4 points whereas pulp bleached at 200°F. loses only 2.1 points.

Figure 8 shows the effect of consistency on the brightness gain in the 4-hr. period. The increased rate of bleaching could be predicted from the fact that the concentration of the peroxide in the aqueous phase is increased as the quantity of water in the bleach system is decreased.

Figure 9 shows that, in the range of 0 to 0.3%, the quantity of sodium hydroxide makes little difference in the results. With more than 0.3% NaOH, bright-

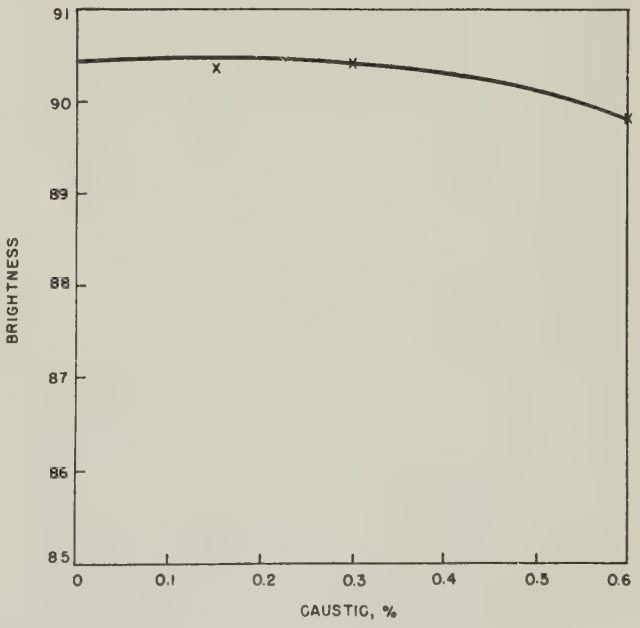

Fig. 9. Effect of alkali concentration on brightness

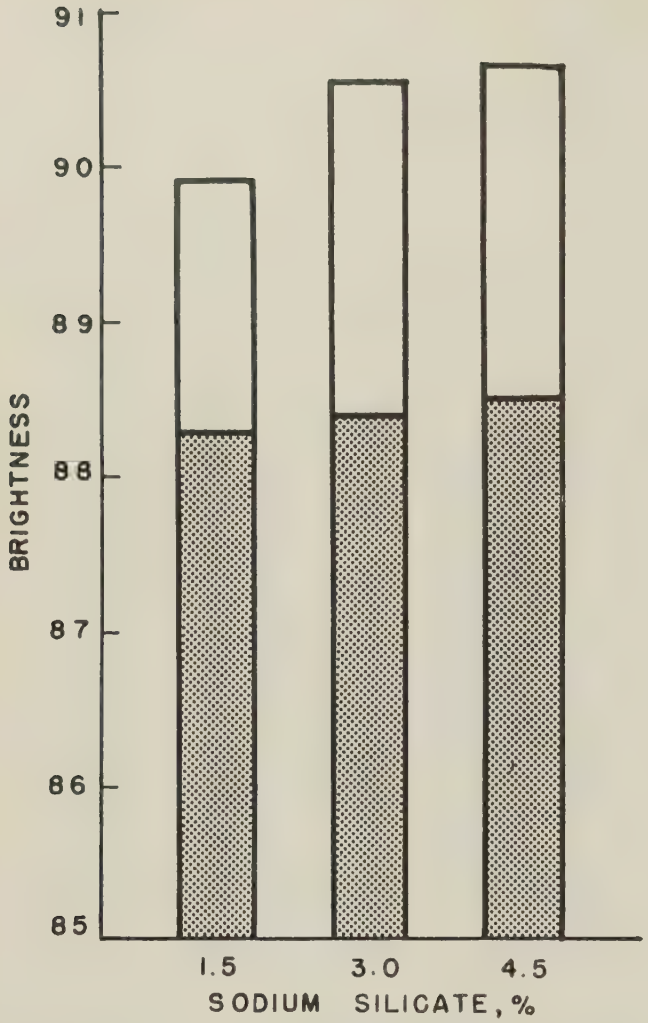

Fig. 10. Effect of silicate concentration on peroxide bleach

ness is decreased. The chief fact shown by these data is that, under normal operating conditions, the bleaching cannot be improved by increasing the alkalinity, even though there is a large quantity of unreacted peroxide present in the pulp.

The effect of quantity of sodium silicate is shown in Fig. 10. In this case 3.0% showed a small advantage over the use of 1.5% but further increases were ineffective. In general, 2 to 3% sodium silicate is required.

Table II. Silicate versus Nonsilicate Bleaching Formulas

Stabilizer	*Silicate*	*Gluconate-borax*	*Gluconate-soda ash*
Bleaching Conditions			
Temperature, °F.	180	160	160
Time, hr.	4	4	4
pH range	10.3–9.2	10.4–9.2	10.3–9.5
Per cent of H_2O_2 unreacted	60	30	6
Pulp Properties			
Brightness	89.5	89.6	88.7
Brightness after heat test	88.2	88.1	87.3
Viscosity, cp.	13.9	13.0	12.1

Notes:

After fourth stage southern pine kraft pulp had 84.0 brightness and a viscosity of 14.8 cp.

Stabilizer-Alkali Formulas:

Silicate: 0.05% Epsom salt, 0.2% NaOH, 3.0% 41°Bé. sodium silicate

Gluconate-borax: 0.05% gluconic acid, 0.3% Epsom salt, 0.5% Borax, 0.4% NaOH

Gluconate-soda ash: 0.05% gluconic acid, 0.05% Epsom salt, 0.28% Na_2CO_3, 0.4% NaOH

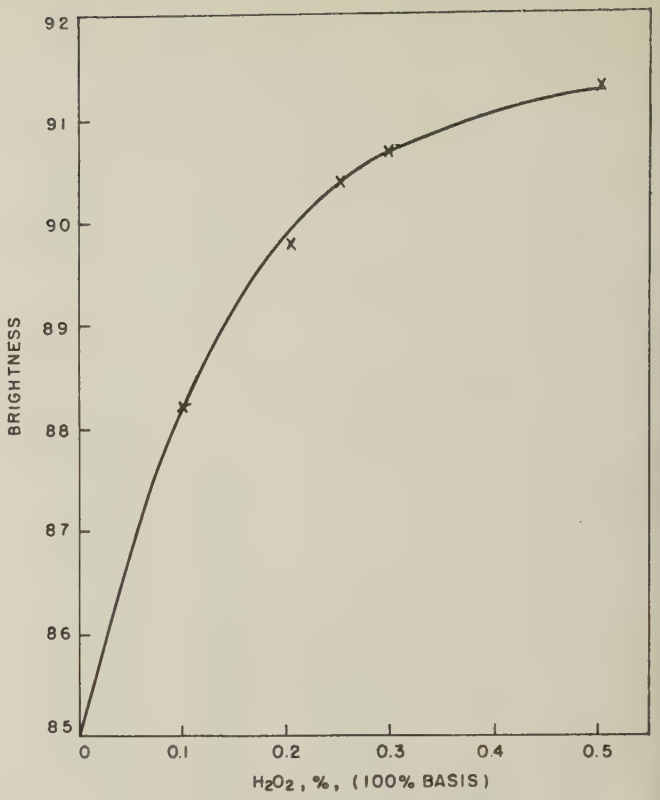

Fig. 11. Effect of quantity of peroxide on brightness

The effect of increasing quantities of peroxide is shown in Fig. 11. The quantity used depends on the results desired. The work reported above was carried out with 0.25% H_2O_2 because the brightness gain per unit of peroxide is less when larger quantities are used.

No viscosity data have been shown for the above bleaches because the values were essentially the same for all pulps in the 90 to 91% brightness range.

The possibility of using peroxide bleaching stabilizers other than the magnesium sulphate-sodium silicate combination has also been studied. Although no other stabilizer has been found which has the versatility of this combination, it has been found that magnesium sulphate, gluconic acid, and certain alkaline buffers will give acceptable results. To obtain good results, it was necessary to limit the bleaching temperature to 160°F. A comparison of the results from two formulas of this type with the standard silicate formula is shown in Table II. Magnesium gluconate stabilization may prove of interest in the peroxide bleaching of "dissolving" pulps where the use of silicate may be undesirable.

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Peroxide Bleaching as a Final Bleaching Process

FERDINAND WULTSCH

Comparable results are given as to an improvement in brightness dependent on the addition of bleaching agents, covering various bleaching agents such as peroxide, bisulphite, and hydrosulphite. The effects of temperature and stock consistency dependent on the reaction time show the advantages of the peroxide bleaching process. At the same time, the effects of the pH and the mixing ratios are investigated and, furthermore, an examination is made regarding the change in brightness with various blends of chemical pulps and groundwood pulps. Comparisons covering the increase in brightness of various pulp grades are made to elucidate the practicability of using peroxide. The one stage bleaching process for sulphite pulps using peroxide was also investigated and the use of the calcium hypochlorite bleaching process in combination with the peroxide bleaching process to obtain an improvement in brightness in the absence of specks, and an improvement in strength is briefly taken into consideration.

AN EXHAUSTIVE report on the use of peroxide as the sole bleaching agent for a sulphite pulp was given by Gärtner and the author in the book "The Peroxide Bleaching of Chemical Pulp and Groundwood Pulp" published by the German Gold and Silver Refinery. But more important to the author than all the abovementioned research work are the results of those investigations obtained in a final stage of bleaching sulphite pulps by means of peroxide.

During the recent years the demand for high brightness of chemical pulps has been considerably increased. Efforts have been made to achieve this desirable effect by multistage bleaching by means of chlorine and hypochlorite. For this purpose special conditions of operation, such as high alkalinity and lower temperatures with comparatively long bleaching times, had to be chosen to keep unavoidable attacks on the fibers within tolerable limits.

In the multistage bleaching with chlorine and hypochlorite brightness degrees up to 90% have been achieved, but in this process losses in strength were hardly within the limits of tolerance. Until recently chlorine dioxide bleaching was the only feasible way to attain higher brightness without losses in strength. Difficulties with the apparatus and high costs in the production of this bleaching agent have tended to favor the peroxide bleaching process.

In the following tables are shown comparative bleaching tests with chlorine dioxide and peroxide on various chemical pulps.

Table I shows chiefly the effect on the viscosity and the copper number. These tests were carried out on unbleached sulphite pulp and on the same pulp prebleached (chlorination and alkalization).

Table II gives the results of a series of final bleaching tests carried out on various commercial sulphite pulps. The sulphite pulps were bleached with chlorine and were tested as to their brightness, copper number, and copper viscosity.

The pulps bleached with the above two bleaching agents were tested. The results showed that the cellulose fiber is resistant against the treatment by both chlorine dioxide and peroxide. The viscosity and the copper number remain nearly unaltered by these agents.

According to these tests there is a tendency for the improvement of viscosity after the final bleaching with both bleaching agents. This might be traced to the extraction of constituents which do not improve the fiber strength. However, both bleaching agents give nearly the same brightness.

A greater difference exists in the use of both final bleaching agents. In the peroxide bleaching an

Table I

	Brightness, %	*Copper no.*	*Copper viscosity, cp.*
Untreated sample	67.5	1.51	101.8
Bleaching with 5.2% ClO_2 at 85°C., pH 3, 1 hr.	76.3	1.39	70.0
Bleaching with 4% Na_2O_2, 3% sodium silicate, pH 10.5, 20°C., 48 hr.	79.6	1.33	102.9
Pulp prechlorinated and alkalized, then bleaching with 0.7% ClO_2 at 85°C., pH 3, 1 hr.	84.2	1.28	88.1
Bleaching with 1% Na_2O_2, 3% sodium silicate, 20°C., pH 10.5, 48 hr.	86.7	1.45	88.4

Table II

	Brightness, %	*Copper no.*	*Copper viscosity, cp.*
A. Untreated sample	87.8	1.46	52.2
Final bleach with 1.5% Na_2O_2, 2.5% sodium silicate, 20°C., pH 10.5, 48 hr.	94.2	1.46	52.7
Final bleach with 1.5% $NaClO_2$ = 0.37% ClO_2, pH 3.8, 85°C., 3 hr.	94.1	1.39	49.1
B. Untreated sample	87.7	3.03	9.5
Final bleach with 1% Na_2O_2 + 2% sodium silicate, pH 10.5, 70°C.	92.1	2.29	9.5
0.37% ClO_2, pH 3, 75°C.	90.1	2.48	10.0
0.74% ClO_2, pH 3, 75°C.	92.2	2.47	10.1
1.1% ClO_2, pH 3, 75°C.	92.3	2.35	10.4
1.48% ClO_2, pH 3, 75°C.	92.7	2.20	10.2
C. Untreated sample	88.4	1.46	33.3
Final bleach with 1% Na_2O_2 + 2% sodium silicate, pH 10.5 50°C.	94.5	1.25	30.2
0.37% ClO_2, pH 3, 75°C.	89.5	1.34	33.6
0.74% ClO_2, pH 3, 75°C.	89.8	1.30	38.4
1.1% ClO_2, pH 3, 75°C.	91.6	1.34	41.0
1.48% ClO_2, pH 3, 75°C.	91.2	1.27	40.1
D. Untreated sample	87.9	2.28	19.5
Final bleach with 0.5% Na_2O_2 + 3% sodium silicate, pH 10.5, 20°C.	94.0	1.74	24.6
0.37% ClO_2, pH 3.80°C.	91.6	1.79	26.0

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Table III

Bleaching: Hypochlorite prebleach, % Cl	Bleaching: Peroxide final bleach, % peroxide	Brightness, %	Viscosity, cp.	Copper no.	Tensile strength, m.	Tear factor cm. g./cm.
Unbleached pulp	Unbleached pulp	69.7	43.3	1.65	2100	113
2	...	75.0	40.4	1.84	1319	75
2	1	84.5	59.1	1.61	1400	92
2	2	87.7	55.6	1.70	1570	84
3	...	86.8	44.8	1.67	1460	85
3	1	90.0	47.6	1.69	1520	81
3	2	91.2	48.4	1.66	1560	79

alkaline medium is required to obtain optimum bleaching effects and in chlorine dioxide bleaching, an acid medium. Furthermore, peroxide bleaching may result in a change at both high or normal temperatures with corresponding shorter or longer reaction times, while the treatment with chlorine dioxide gives optimum bleaching only at temperatures over 60°C. The apparatus for both bleaching processes differs widely. Because of the highly corrosive effect of chlorine dioxide this bleaching process may be carried out only in suitable materials, the selection of which is limited. The treatment with peroxide may be carried out with equipment constructed of concrete, wood, stoneware, iron containers covered with rubber, or in containers of high-duty steel.

In Table III are shown final bleaching tests. These tests were carried out after a preliminary one-stage bleaching with hypochlorite. These tests were made with reasonably soft sulphite pulp with a Johnson-Noll number of 29.3, produced at the pulp mill at Rechberg, Arland.

Experiments which indicate the differences in the continuous cold bleaching process at high concentration in an alkaline medium on a Kamyr machine compared with the fully continuous bleaching process on a wet machine with a drier section are discussed next. Table IV shows these differences.

The pulps were prebleached in a bleaching engine with 3.2% Cl as calcium hypochlorite, then washed and dewatered on the Kamyr wet machine to a dry content of 43%. Following the dewatering bleach liquor was added to the pulp by a special mechanism at a uniform rate. Then the pulp reels were stored for about a fortnight in which period the bleaching process was carried out.

These plant trials showed that brightness degrees of more than 90% may be obtained by peroxide bleaching of pulps prebleached with chlorine, while the strength qualities can be held on the same level as those of the unbleached pulp. At the same time, the influence of the caustic soda on the physical strength qualities of the pulp can be seen. Even when using caustic soda it is largely possible to obtain the same brightness degrees without reduction in strength by reduced addition of alkali than can be achieved by a larger addition of caustic soda.

In these experiments the strength tests were carried out with unbeaten pulps.

In Table V plant tests are shown, carried out with a sulphite pulp prebleached with chlorine, where the final bleaching took place in both the Kamyr wet machine and the drier section of a normal wet machine. Additional beating tests were carried out on all the pulps using beating periods of 10 to 60 min. Comparisons of tensile strength values were made between pulp prebleached with chlorine and pulp finally bleached with peroxide. These plant tests were carried out with a normal pulp (Roschier no. 60) and pulp of normal strength (Roschier no. 54).

In these tests the pulps received but a preliminary bleaching in the beater with about half the amount of chlorine normally required for a straight hypochlorite bleaching process; then the pulps were washed and dewatered on the wet machines and finally dried. On these machines the peroxide solution was added through a special mechanism and was uniformly distributed over the whole pulp sheet. The still wet pulps treated on the Kamyr machine were stored in reels for 8 to 14 days and then converted to paper at the Arland paper mills A./G. at Graz.

The reaction period in the test results listed in this table was 9 days.

Table IV. Final Bleaching of Chlorine Prebleached Sulphite Pulps on the Kamyr Wet Machine

	Brightness, %	Tensile strength, m.	Folding strength	Tear factor, cm. g./cm.	Viscosity, cp.	Copper no.
Pulp A Roschier no. 53						
Unbleached pulp	64.9	4000	49	140	31.4	1.85
Pulp prebleached with 3.2% of chlorine	87.6	3600	30	139	22.0	1.54
Final bleach of pulp with 1% H_2O_2, 0.25% NaOH, 0.5% sodium silicate	91.6	3900	65	176	22.7	1.46
Final bleach of pulp with 1% H_2O_2, 0.5% NaOH, 1% sodium silicate	91.5	3200	32	164	22.7	1.54
Pulp B Roschier no. 66						
Unbleached pulp	66.9	4000	49	137	33.6	1.69
Pulp prebleached with 3.2% of chlorine	88.8	3640	50	194	19.9	1.65
Final bleach of pulp with 1% H_2O_2, 0.25% NaOH, 0.5% sodium silicate	92.9	4240	155	158	23.2	1.70
Final bleach of pulp with 1% H_2O_2, 0.5% NaOH, 1% sodium silicate	93.0	2840	26	143	23.1	1.55
Final bleach of pulp with 1% H_2O_2, 2.5% NaOH, 5% sodium silicate	92.6	3480	44	128	21.7	1.40

Table V. Final Bleaching Tests of Chlorine Prebleached Sulphite Pulps on the Kamyr Machine and on the Drying Section

	Brightness, %	*S.-R. beating degree after a beating time, min., of:*						*Tensile strength in meters after a beating time, min., of:*					
		10	*20*	*30*	*40*	*50*	*60*	*10*	*20*	*30*	*40*	*50*	*60*
Unbleached Roschier no. 60	62.6	15.5	20	30	38.5	48	60	7080	7760	9000	9450	9220	9590
Prebleach 3.5% Cl_2, 4 hrs., 43° C.	82.2	20	33.5	50	56	63.5	68	5025	5375	5330	5480	6000	6400
Final bleach on the Kamyr machine													
0.5% H_2O_2, 0.75% NaOH	91.2	20	31	40	51	60	74.5	5670	5490	5810	5420	6040	5290
1.5% sodium silicate 1% H_2O_2, 1% NaOH	91.4	20	33	39.5	55	64	69	5630	5550	5660	5650	5530	5460
2% sodium silicate													
1.5% H_2O, 1% NaOH, 2% sodium silicate	91.7	19	28	39	47	54	66	5500	5130	5550	6260	5100	5780
Final bleach on the drying section													
0.22% H_2O_2	91.0	18.5	30	41	52	59	67	5090	5810	5730	5550	5800	6700
0.43% H_2O_2	92.0	20	30	44	55	66	74	4730	5550	5560	5810	5820	5510
0.57% H_2O_2	91.9	17	31	42	51	61	70	4440	4810	5250	5770	5700	5830
Unbleached Roschier no. 54	63.4	16	20	26.5	31	40	51	8210	9170	9210	9400	9060	10450
Prebleach 4% Cl_2, 3.5 hr., 42°C.	84.0	17	24	37	43	50	61	3600	4660	4140	6380	6330	5220
Final bleach on the Kamyr machine													
0.5% H_2O_2, 0.75% NaOH, 1.5% sodium silicate	92.8	18	28	27	46	52	57	4380	5150	5350	6100	5940	5610
1% H_2O_2, 1% NaOH, 2% sodium silicate	91.7	19	31	40	47	54	60	4780	5260	2510	5490	5600	5530

With pulps bleached with peroxide in the drier section a storing or reaction period is not required due to their heating treatment; the strength tests, however, were carried out only 8 days after drying.

The results show that by the use of peroxide it is possible in both final bleaching methods to achieve an increase in brightness of 8.2 to 9.4% in pulps but partly bleached with chlorine. The consumption of bleaching agents was 0.5 to 1% of peroxide. An increase of peroxide to 1.5% gave no appreciable improvement.

The tensile strength values of the sheets made from these pulps, tested according to the German Standard method, were almost the same as the values stated for the final bleached pulp prebleached with half the amount of hypochlorite. This means that a brightness of more than 91% could be achieved without further losses in strength. Prior to beating the pulps had to be acidified. The beating degrees of the pulps finally bleached with peroxide on the Kamyr machine compared with the beating degrees of original pulps prebleached with chlorine only, show with shorter beating periods of 10 to 40 min. a somewhat slower development. Beating periods of more than 1 hr. gave almost the same beating degrees for both final bleached pulps and pulps prebleached with chlorine only. The pulps that received a final bleaching in the drier section behaved quite similarly in the beating process as a pulp not subjected to a final bleaching. These plant tests showed no appreciable differences in beating amenability and in tensile strength values of wood pulps partly prebleached with chlorine and those finally bleached with peroxide to maximum brightness degrees.

REDUCTION IN IMPURITIES OF WOOD PULP

When examining the suitableness of a final bleaching with peroxide we were highly interested in the problem of reducing the impurities (dirt specks) in the wood pulp. We subjected wood pulps prebleached once with calcium hypochlorite to a final bleaching with hypochlorite in the beater. Another sample of partly bleached wood pulp received a final bleaching with peroxide to the same brightness degree, avoiding the second bleaching stage with hypochlorite.

In both cases, i.e., in the two-stage hypochlorite bleaching process and in the other (first stage hypochlorite, second stage peroxide), the differences in the number of dirt specks showed results being in favor of the two-stage bleaching with hypochlorite. When we subjected the wood pulp bleached in two stages with hypochlorite to a final bleach with peroxide on the Kamyr machine in an alkaline medium, it resulted in a brightness increase of 4 points, and the percentage of dirt specks decreased by 25%. The wood pulp bleached in two stages with hypochlorite on the wet machine with a drier section, where essentially an acid

Table VI

	A *Two-stage bleaching with hypochlorite 7.2% chlorine*	*B* *Prebleaching with hypochlorite 4.0% chlorine, peroxide bleaching 1% Na_2O_2, 1% NaOH, 2% sodium silicate*	*C* *Two-stage bleaching with hypochlorite 7.2% chlorine, 0.5% H_2O_2, 0.75% NaOH, 1.5% sodium silicate on the Kamyr machine*	*D* *Two-stage bleaching with hypochlorite 7.2% chlorine, 0.6% H_2O_2 with drier section*
Brightness Elrepho	88	82, after prebleaching 88, after final bleaching	88, after two-stage bleaching 92.8, after Kamyr machine peroxide	88, after two-stage bleaching 91.8, after H_2O_2 with drier section
Dirt Specks	0.9	1.4 after prebleaching 0.95 after final bleaching with peroxide	0.9 after prebleaching 0.6 after final bleaching with peroxide	0.9 after prebleaching 0.82 after final bleaching
Tearing strength after 50 min. beating time in the Jokro mill, m.	6600	7800, after prebleaching 7200, after final bleaching with peroxide	6600, after prebleaching 6600, after final bleaching with peroxide	6600, after prebleaching 6300, after final bleaching

medium was used for the bleach, the decrease in dirt specks was only 8%. This indicates that for a decrease in impurities a bleach in an alkaline medium at maximum temperatures of 30°C. is superior to the fast bleaching process with peroxide on the drier section.

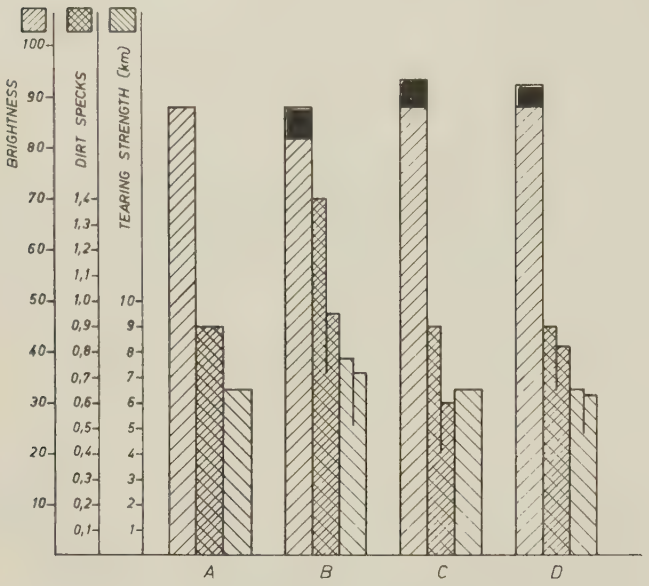

Fig. 1. Brightness, dirt specks, and strength depending on various bleaching processes

A. Two-stage bleaching with hypochlorite 7.2% chlorine, 88% brightness. B. Prebleaching with hypochlorite and 4% of chlorine to 82% brightness and final bleaching with peroxide to 88% brightness. C. Two-stage bleaching with hypochlorite similar to A, however, final bleaching with peroxide to 92.8% brightness. D. Two-stage bleaching with hypochlorite similar to A, however, final bleaching with H_2O_2 to 91.8% brightness. Black: increase in brightness through final bleaching with peroxide and H_2O_2, respectively.

Nevertheless, it must be realized that the alkaline peroxide bleaching at a high pulp consistency and at normal temperatures requires a fortnight; the bleaching process with hydrogen peroxide on the wet machine with drier section was completed within 8 min.

Table VI and Fig. 1 give the brightness, dirt count, and tensile strength of a sulphite pulp bleached by four different processes. The following points can be made.

1. A sulphite wood pulp, bleached in a two-stage bleach system with hypochlorite to a brightness of 88 Elrepho, had a tensile strength of 6600 m. (beating time, 50 min. in a Jokro mill).

2. The same bleached pulp was prebleached only with hypochlorite to a brightness of 82 and received a final bleaching with peroxide on the Kamyr machine to the same brightness of 88. The peroxide bleaching process resulted in an improvement of the tensile strength by 800 m.

3. The wood pulp bleached in the two-stage bleaching process to a brightness of 88 was subjected to a final bleaching with peroxide on the Kamyr machine at a dry content of 50%. The tensile strength of this pulp which had a brightness of 92.8 remained at the value of 6600 m. In spite of this increase in brightness of 4.8 over the two-stage bleaching process no decrease in strength was found.

4. The sulphite pulp bleached in the two-stage bleaching process to a brightness of 88 was subjected to a final bleaching with pure hydrogen peroxide on the wet machine with a drier section and a brightness of 91.8 was obtained. This bleaching process was carried out in an acid medium within 8 min. The surface temperature rose up to 100°C. The final tensile strength was 6300 m. i. e. a decrease of several hundred meters in comparison to that strength obtained in the bleaching with hypochlorite.

In conclusion, the author should like to make the following short comments on the problem of the peroxide bleaching of sulphite pulps.

1. It is economic to prebleach the sulphite pulps with chlorine and hypochlorite in multistage processes and, in order to obtain a high degree of brightness, to subject the pulps to a final bleaching with peroxide.

2. If one intends to achieve a more intensive reduction in impurities it would be advisable to carry out the final bleaching with cold peroxide in a highly alkaline medium and at high consistency.

3. To force the final bleach and to achieve a high degree of brightness in market wood pulp bleaching with hydrogen peroxide on a wet machine with drier section is equally favorable. It is possible to obtain brightness degrees up to 92% without appreciable losses in strength.

4. When the final bleaching is carried out on a Kamyr machine in an alkaline medium, the pulp must be acidified in the stock preparation plant of the paper mill.

When the final bleaching of the sulphite pulp with hydrogen peroxide is carried out on a wet machine with a drier section, the final bleach will be completed at the discharge of the wet machine and the pulp need not be acidified in the stock preparation of the paper mill. In this case, of course, one will have to put up with a certain increase in the percentage of dirt specks in the wood pulp.

Due to these results the operation in our sulphite pulp mill runs as follows.

A. Market sulphite pulp for which a high brightness is demanded and one in which the strength may not decrease considerably, we are bleaching continuously with hydrogen peroxide on the wet machine with drier section. We achieve brightness degrees up to 92%.

B. For our own paper mill we are bleaching the sulphite pulp to be used for papers with a high brightness and maximum strength on the Kamyr machine at a dry content of about 50% and then this pulp is subjected to a final bleach with peroxide in a highly alkaline medium at a pH of approximately 10.5. The pulp is then stored for 10 to 14 days. We achieve a brightness of 92 to 93%, the percentage of dirt specks is reduced by 20%, and we obtain a high strength in addition to a high brightness.

It should be pointed out that these tests and reports covering these experiments may not be considered to be entirely complete. It was but the author's intention to give a short report on the results covering the research work in our plants on the peroxide bleaching process and on the reduction in the percentage of dirt specks. A more detailed report on this bleaching process will be given at a later date.

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Classification of Pulps According to Supermolecular Structure of Cellulose

L. R. PARKS

X-ray and lateral order distribution (LOD) data permit the assignment of pulps to definite groups. Both the pulping process used and the species type decide the classification of the pulp according to its supermolecular properties. Data from x-ray diffractometer charts can be a valuable aid in following pulping processes and analyzing the final products. Pulp purification steps usually cause a definite sharpening of the x-ray pattern. Interesting differences in the resolution of x-ray peaks occur with process and species changes.

THE vast majority of the x-ray work on cellulose appearing in the literature has been done on regenerated cellulose, particularly yarns. Considerable work has also been done on long fibered native cellulose such as cotton and ramie (*1*). These materials have the advantage of facile orientation in the x-ray beam which aids sample handling and interpretation of results. X-ray analysis of pulp with fiber lengths near 1 to 2 mm. is more difficult, particularly camera methods, and use of this technique has not been as extensive as with the longer fibered products.

The rapid development of diffractometers utilizing reflectance technique with Geiger counter detection (para-focusing geometry) (*2*) since World War II has provided an easy, efficient method for studying pulp which we have found to be of considerable aid in cellulose research.

METHODS AND RESULTS

Treatment of pulp sheets as a powder sample in the x-ray diffractometer permits calculation of the widths of diffraction peaks directly from the recorder chart. The peak width, taken at the point of half maximum by convention, is inversely proportional to the size of the ordered regions in the sample (*3*). We have learned that pulps can be readily grouped into several categories. This can be done according to the half-width of the main peak (002, at 22.5° two theta) in the cellulose-I pattern. The results as degrees 2-theta, are given in Table I. The term "scatter" indicates the spread or width of the peak. Linters have appreciably larger ordered regions than wood pulps, and prehydrolyzed sulphate wood pulp ordered regions are significantly larger than those in sulphite wood pulp, at the same purity level. The two nonprehydrolyzed sulphate pulps (paper grade) show the effect of low purity in spreading the x-ray pattern.

A commercial dissolving pulp sheet sample is usually a reasonable powder sample for diffractometer work as it comes off the machine. Such factors as sample fuzziness, surface roughness, wire versus felt side, etc., had no appreciable effect on the diffraction pattern. There is a minimum thickness of near 0.04 in. which is necessary to obtain sufficient intensity. Density has a large effect on the intensity of the x-ray pattern but does not change the width at half maximum over a wide range of densities. Diffraction patterns were taken with a North American Philips x-ray unit. Radiation from a copper target tube operated at 45 kv. and 15 ma. with a nickel filter was used throughout this work. A rotating specimen holder was used to minimize preferred orientation but was found to be unnecessary. The beam was collimated with a 1° divergence slit and a 0.003-in. receiving slit.

Species and pulping histories cause other differences in the x-ray pattern. The secondary peak on a cellulose-I diffraction pattern is a doublet from the 101 and $10\bar{1}$ planes. Resolution of the two peaks on a linters pattern is evident in Fig. 1. Downward dips (attempts at resolution) on prehydrolyzed sulphate pine pulp patterns can also be seen in Fig. 2. The top of the doublet in the sulphite pattern is flat (Fig. 3) and a sulphate gum (Fig. 4) has a round, smooth peak almost analogous to cellulose-IV (*4*).

Purity has a definite effect on the x-ray diffraction pattern of a pulp. Table II contains data showing the sharpening of the peaks with increasing severity of prehydrolysis conditions and bleaching, both of which are purification steps.

Table I. X-Ray Diffraction Scatters for Typical Pulps

Sample	*Widths of the 002 cellulose defraction peaks at half maximum in degrees 2 theta*
Linters	
Linters, acetate	1.32
Linters, viscose	1.30
Linters, chemically modified	1.32
Sulphates prehydrolyzed	
Southern pine, cellophane	1.78
Southern pine, cellophane	1.76
Southern pine, textile	1.72
Southern pine, tire cord	1.80
Fir, cellophane	1.80
Gum, tire cord	1.78
Gum, tire cord	1.76
Southern pine, tire cord	1.80
Southern pine, acetate	1.72
Southern pine, acetate	1.74
Sulphites	
Southern pine, textile grade	2.02
Hemlock, cellophane	1.90
Hemlock, cellophane	1.94
Southern pine, acetate	1.86
Mixed hardwoods, cellophane	2.06
Aspen-fir, cellophane	2.06
Canadian spruce, textile	2.10
Spruce, textile	1.92
Southern pine, acetate	1.86
Hemlock, acetate	1.84
Sulphates, non-prehydrolyzed	
Fully bleached kraft	2.02
Semibleached kraft	2.00

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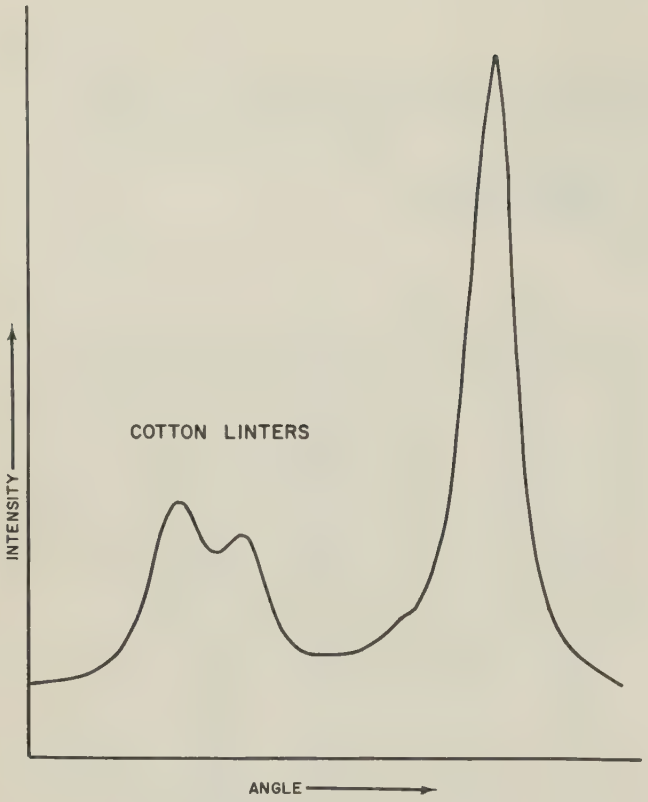

Fig. 1. Diffraction pattern from cotton linters

X-ray diffraction has been justifiably criticized for being insensitive to partially ordered regions and somewhat unidirectional in its approach to structure. Lateral order distribution (LOD) determinations, as discussed by Howsmon and Sisson (*5*), surely permit more conclusive descriptions of the overall, three dimensional order in pulp samples. The use of the x-ray diffractometer as described by McCarthy and Anker-Rasch (*6*) provides a particularly simple means of LOD determination. Resistance to swelling with aqueous sodium hydroxide is a function of the order of the system. The amount of change (swelling) produced by the caustic in the ordered regions is measured by determining the amount of cellulose-II in the sample after 1 hr. steeping time at 0°C. This can be followed by other means, water regain, calorimetry, and others, but none are as easy or as rapid as the cellulose-II determination with the diffractometer.

A plot of the change in per cent cellulose-II with the change in sodium hydroxide concentration versus the per cent sodium hydroxide gives distribution curves

Table II. Effect of Prehydrolysis Conditions and Bleaching on 002 Scatter

Sample no.	*Conditions*	*Bleached scatter (Widths of the 002 cellulose defraction peak at half maximum in degrees 2 theta)*	*Unbleached scatter*
423	30 min. to 50 p.s.i. 0 hold	2.02	2.12
419	30 min. to 70 p.s.i. 0 hold	1.98	2.08
420	30 min. to 90 p.s.i. 0 hold	1.98	2.02
424	30 min. to 110 p.s.i. 0 hold	1.92	1.94
417	30 min. to 30 p.s.i. 30 min. hold	1.92	2.06
418	30 min. to 70 p.s.i. 30 min. hold	1.82	1.92
421	30 min. to 90 p.s.i. 30 min. hold	1.90	1.98
422	30 min. to 110 p.s.i. 30 min. hold	1.88	1.96

Table III. Lateral Order Distribution Data

Sample	*X-ray* Order	*X-ray* Order distribution	*Water regain* Order	*Water regain* Order distribution
Linters				
Acetate	9.3	Narrow		
Viscose	9.2	Narrow	9.2	Narrow
Sulphates				
Southern pine, cellophane	8.7	Wide	8.5	Wide
Southern pine, textile	8.6	Wide	8.7	Wide
Southern pine, tire cord, low viscosity	8.1	Wide		Wide
Southern pine, acetate	8.4	Wide	8.0	Wide
Southern pine, tire cord, high viscosity	8.3	Wide		
Fully bleached kraft	8.2	Wide		
Semi-bleached kraft	8.2	Wide		
Douglas-fir, cellophane	8.2	Narrow	7.8	Narrow
Gum, tire cord	8.2	Wide	8.1	Wide
Southern Pine, textile, high viscosity	8.3	Wide		
Sulphites				
Hemlock, cellophane	7.2	Very narrow	6.6	Very narrow
Southern pine, cellophane	7.5	Narrow		
Aspen-fir, cellophane	7.6	Narrow		
Hemlock, cellophane	7.0	Very narrow		
Hemlock, acetate	7.5	Narrow		
Southern pine, acetate	8.0	Very narrow		
Southern pine, textile	7.7	Narrow	7.5	Narrow
Hemlock, acetate	7.8	Narrow		
Spruce-fir, acetate	7.8	Narrow		
Canadian spruce, textile	7.1	Very narrow		
Southern pine, textile	7.8	Narrow		

indicative of the lateral order distribution. Plots of this type are found in Fig. 5 and are similar to many previously reported in the literature by Marchessault (*7*) and others. Data from curves similar to those in Fig. 5 again permit classification of pulps into groups.

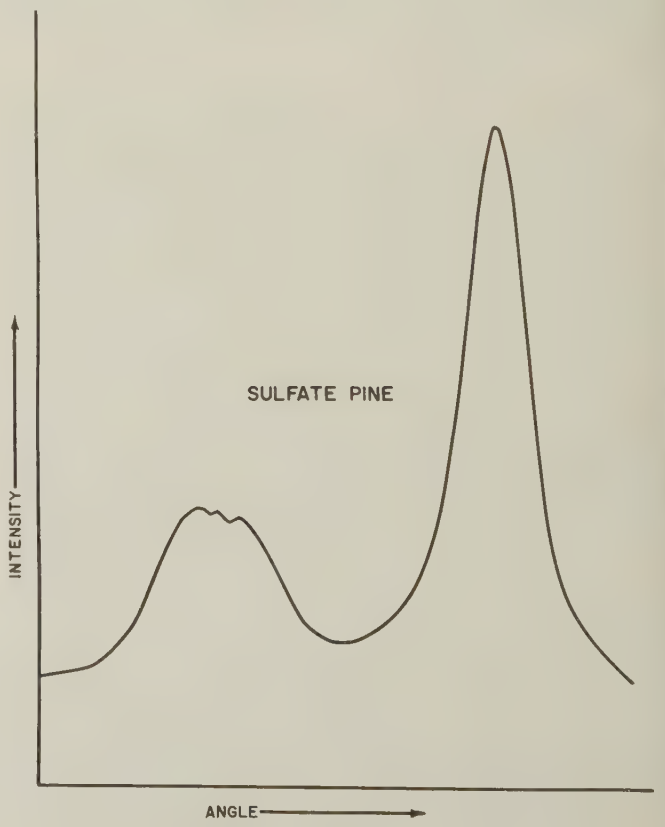

Fig. 2. Diffraction pattern from sulphate pine

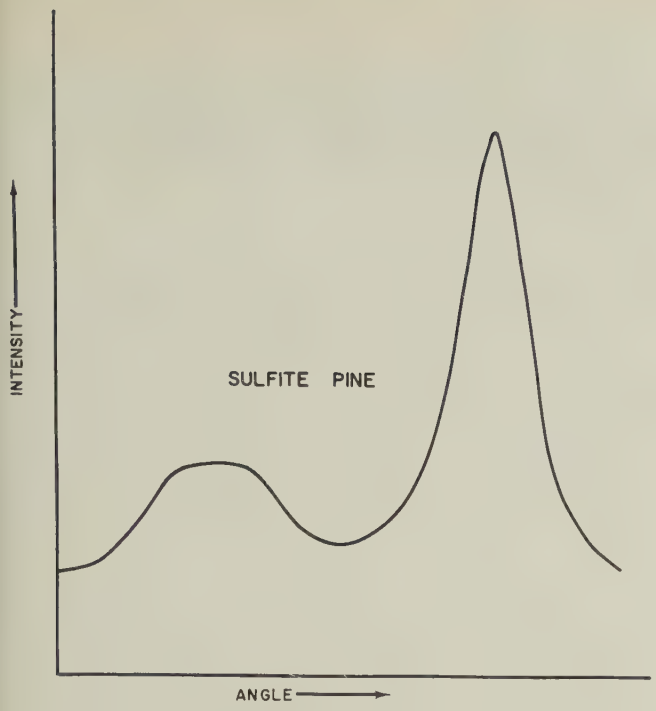

Fig. 3. Diffraction pattern from sulphite pine

Order is defined as the caustic required for half mercerization and the order distribution is an attempt to describe the curve, i.e., the over-all order of the system.* The water regain data in the table for comparison agree with Ranby's observation (*8*) that this method is slightly more sensitive than the x-ray but it is also far more laborious.

CONCLUSIONS

The following conclusions seem justified from the above data, considering x-ray and LOD simultaneously:

1. The sulphite wood pulp ordered regions are small in size and uniform in perfection of order.
2. Linters ordered regions are large in size and also uniform in perfection of order.
3. The sulphate wood pulps have ordered regions intermediate in size, and with varying degrees of perfection covering the entire spectrum of the other two types.

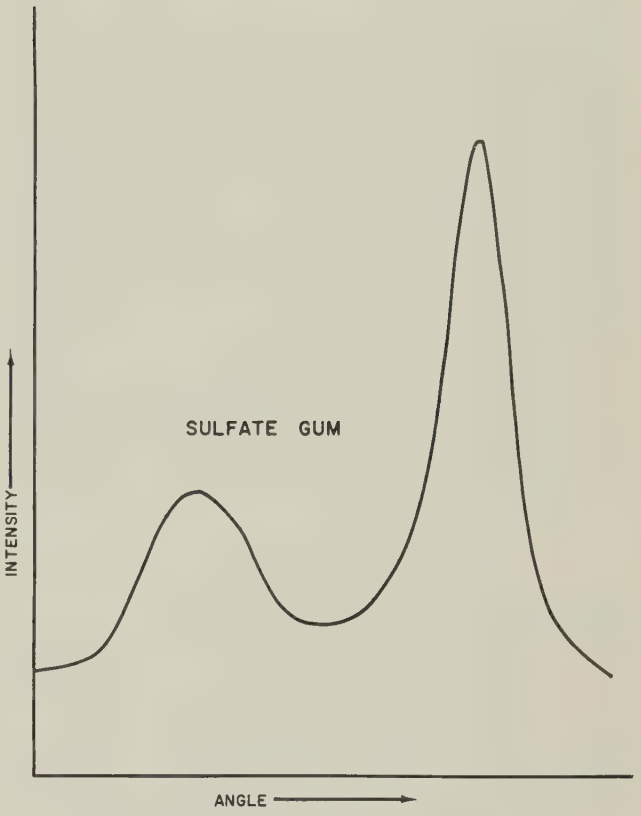

Fig. 4. Diffraction pattern from sulphate gum

Some aspects of the application of x-ray techniques to research on pulp have been covered in this discussion. Variations in peak resolution with species and process were illustrated. Examples were given of the use of x-ray as an analytical tool in following pulp purification. It was shown that pulps can be grouped readily by comparing their x-ray and LOD parameters.

* Order in the per cent sodium hydroxide required to give 50% mercerization in 1 hr. at 0°C. and order distribution is a description of the width of the distribution curve at half maximum.

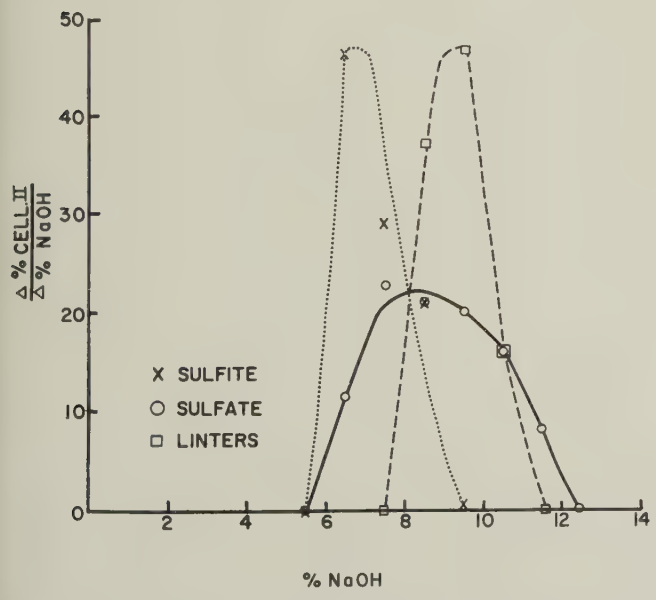

Fig. 5. Lateral order distribution curves for a typical sulphite pinewood pulp, prehydrolyzed sulphate pine wood pulp, and cotton linters

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The Importance of Chip Moisture in Kraft Pulping

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The use of air-dry chips in laboratory kraft pulping studies has two advantages. The chips may be stored without spoiling and more accurate determinations of moisture content may be made. Since the precise determination of the amount of dry-wood pulped is essential to reproducible yield determinations, the second advantage is very real in accurate laboratory pulping studies. With these advantages in view, the effect of pulping air dry wood was investigated. Also the work was extended to the cooking of chips rewetted with water by a preimpregnation procedure. The dry chips showed lower screened yields and pulp quality, but the rewetted chips cooked to essentially the same pulps as fresh chips treated under the same conditions. In addition some work was done on studying the effects of preimpregnation with weak alkali to prevent acid hydrolysis in the fiber lumens. This preimpregnation did not produce beneficial results, and it must be inferred that no acid hydrolysis takes place in normal kraft cooking.

THIS work was undertaken, originally, to ascertain whether it would be possible to use dry wood chips in laboratory kraft pulping experiments instead of the usual green, or wet chips used in the mill. The use of these dried chips would present a definite advantage from a standpoint of accuracy in yield determination. The normal experimental digester uses from 1000 to 3000 g. oven-dry wood per charge. It is very difficult to accurately determine the moisture content of such small quantities of chips when they contain 40 to 50% moisture. Any uncertainty in this initial chip moisture leads to an unreliable value for weight of wood charged to the digesters with consequent inaccuracy in final yield determinations. The use of dried chips would eliminate this source of error.

However, if dried chips cook at a different rate or are degraded to a greater extent than wet chips the results become useless because they cannot be interpreted in terms of mill operations where wet chips are used. If dry chips do have pulping characteristics different from those for wet chips, would it be possible to dry the chips for accurate weighing of the digester charge, then return the chips to their original moist condition through preimpregnation procedures without altering their pulping characteristics? Some authorities state that drying of the wood collapses the lumens of the fiber so that a pulp of poor quality and yield results. It was primarily to answer such questions as these that the work was undertaken.

As the work progressed, the scope of the project increased, as is usually the case. Early experiments showed that it was possible to dry out the chips, then put water back into the chips by preimpregnation without altering the pulping characteristics. If water can be returned into the lumens of the fiber, why not use dilute solutions of various chemicals? The writer has often wondered whether some form of acid hydrolysis might not be occurring in the fibers near the center of the chips while the alkali reaction is working toward the center. Such hydrolysis would be possible due to the formation of wood acids in the fibers at the cooking temperature. Therefore, dilute solutions of bicarbonate, carbonate, and sulphite were used as impregnants to determine whether their presence inside the chip would alter the end results in kraft pulping.

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METHOD OF PROCEDURE AND PRESENTATION OF DATA

The bulk of the investigation was concerned with pulping at constant steam pressure, or continuous-type cooking. For that reason it was necessary to use shredded chips. Slash pine chips, of the usual mill size, were obtained from the chippers of The Hudson Pulp and Paper Corp. at Palatka, Fla. The chips were shredded in the rotapulper, using a plate clearance of 0.900 in. Shredding conditions were adjusted so that 25.3% of the product was oversize, made up of cross sections too large to pass endwise through a 3-mesh screen. This procedure insured that there would be only 1 to 2% of fines, material smaller than 10 mesh. The shredded product was screened on a 3-mesh screen to remove oversize—all material—passing through this screen being set aside for pulping experiments. Half of the screened product was air-dried, the other half being stored in covered cans to maintain moisture content.

In all of the continuous type experiments an initial concentration of 35 g. Na_2O per liter and 25% sulphidity were used. Rather high liquor-to-wood ratios were used, between 8 and 10:1. This high liquor ratio required that wood charged to the digester be limited to about 1000 g. (oven-dry basis) per cook, since the maximum capacity of the digesters is only 13 l.

The equipment and procedure used for continuous type cooking have been described elsewhere (*1, 2*). In these procedures, a weighed quantity of chips was charged to one of the digesters which had been previously brought to full cooking pressure. A measured quantity of cooking liquor, heat heated in the liquor storage tank to 20 p.s.i. higher than cooking pressure, was charged to the digester. Immediately after charging, rotation of the digester was started (3 r.p.m.) and continued until just before blowing. The cook was blown into the cyclone blow pit, transferred to a canvas bag and washed with a water spray at 170°F. for about 2 hr. The washed pulp was screened on a 10-cut screen in the Valley laboratory flat screen. Screenings were oven-dried and weighed. The screened pulp was pressed to about 25% oven-dry, broken up, and stored in moisture-tight cans. After 24 hr. the pulp was sampled for moisture content. From the original weight of pressed, screened pulp and its moisture content, the screened

yield was calculated. Total yield was arrived at by adding dry screenings and dry screened pulp.

All of the screened pulps were analyzed for lignin, using the TAPPI method with 72% H_2SO_4. Viscosities of all but the extremely raw pulps were determined, using the 0.5*M* cupriethylenediamine method outlined in TAPPI Standard T-230. Viscosity values were converted to degree of polymerization through the use of the Hercules conversion chart. In the viscosity measurements lignin interference was avoided by complete delignification of the pulp samples with sodium chlorite and acetic acid.

Pulping experiments were carried out for both wet and dry shredded chips at 125, 140, and 155 p.s.i.g. steam pressure. For each steam pressure six cooks were made, varying in time between 10 and 45 min. In several cases, complete series of cooks were repeated in order to provide a check on the original results. All of the cooking data are listed in Table I and are shown graphically in Fig. 1.

Another group of experiments involved the impregnation of dry shredded chips with water and dilute solutions of sodium bicarbonate, sodium carbonate, and sodium sulphate. The impregnation procedure was carried out in the following manner. Sufficient chips for a cook were carefully weighed, then submerged in water or the dilute solution to be used. The solution was then brought to a boil in about 15 min. and maintained at the boiling point for 5 min. The mixture was then cooled in 10 min. to 140°F. Chips were drained for 10 min., weighed and charged to the digester. By this procedure the moisture content of the chips was raised from an initial value of about 8% to a final value of about 55%. Knowing about how much liquid

Table I. Effect of Chip Moisture—Continuous-Type Kraft Pulping

Slash pine shredded chips, sulphidity of 25% in all cooks

		Cooking liquor					Yield, %		Analysis of screened pulp		
Cook no.	Moisture in chips, %	Initial conc. (g. Na_2O per l.)	Liquor ratio (g. liquor per g. O.D. wood)	% Chem. as Na_2O	Steam pressure, p.s.i.g.	Cooking time, min.	Total	Screened	Lignin, %	Pentosan, %	D.P. no.
2849	7.2	35.1	9.5:1	32.1	125	10	68.4	4.3	24.7	...	...
2850						18	60.6	16.1	19.1	...	...
2851						23	55.9	36.2	15.5	...	1679
2852						30	51.1	45.0	12.4	...	1634
2853						38	48.2	46.3	9.2	...	1585
2854						45	46.3	45.7	7.1	...	1524
2813	8.4	35.0	9.3:1	31.3	140	10	66.0	7.2	23.7	...	...
2814						15	58.7	22.9	17.6	...	...
2815						20	53.6	38.4	13.9	...	1664
2816						25	50.3	42.0	10.6	...	1597
2817						30	47.2	43.3	8.2	...	1499
2818						40	43.8	43.0	5.4	...	1368
2825	8.2	35.0	9.3:1	31.3	140	10	65.8	7.4	22.5	...	...
2826						15	59.8	22.1	17.8	5.8	...
2827						20	53.4	37.9	12.4	...	1605
2828						25	50.1	42.0	10.2	...	1581
2829						30	46.7	43.3	7.4	...	1501
2830						40	44.1	43.2	5.3	4.8	1358
2843	7.6	35.1	9.3:1	31.4	155	10	63.4	16.4	19.8	...	...
2844						15	54.2	39.2	12.7	...	...
2845						20	49.4	43.2	9.5	...	1505
2846						25	46.6	43.3	7.3	...	1409
2847						30	44.6	43.3	5.2	...	1337
2848						35	43.2	42.6	4.2	...	1238
2873	41.7	34.7	7.8:1	26.2	125	10	69.8	4.3	22.1	...	...
2874						18	62.2	15.8	17.1	...	...
2875						23	58.5	27.5	15.1	...	1760
2876						30	54.0	42.3	12.4	...	1726
2877						38	51.7	48.0	9.7	...	1649
2878						45	50.1	48.5	8.2	...	1597
2861	41.9	35.0	7.9:1	25.6	140	10	69.3	4.8	21.9	...	...
2862						15	61.0	20.6	16.6	5.7	...
2863						20	56.0	38.0	13.7	...	1690
2864						25	52.9	47.3	10.9	...	1637
2865						30	49.0	46.9	8.9	...	1574
2866						40	46.8	46.5	5.8	4.8	1495
2891	40.7	35.0	8.2:1	27.7	140	10	66.7	7.0	20.1	...	...
2892						15	60.7	23.5	15.7	...	...
2893						20	55.6	40.9	12.4	...	1642
2894						25	51.9	47.0	9.9	...	1570
2895						30	49.9	47.7	7.7	...	1548
2896						40	46.4	46.0	5.3	...	1403
2867	39.9	34.7	7.2:1	25.5	155	10	65.5	12.2	18.8	...	...
2868						15	58.5	33.3	14.1	...	...
2869						20	53.1	43.4	10.7	...	1614
2870						25	50.2	44.9	8.2	...	1512
2871						30	48.5	46.1	6.3	...	1459
2872						35	47.8	46.6	5.0	...	1398
2897	40.9	35.0	7.8:1	26.4	155	10	63.0	14.2	17.4	...	...
2898						15	55.7	41.5	12.1	...	...
2899						20	50.8	46.2	8.5	...	1548
2900						25	48.3	46.7	6.8	...	1499
2901						30	46.0	45.4	4.5	...	1395
2902						35	44.9	44.6	3.7	...	1311

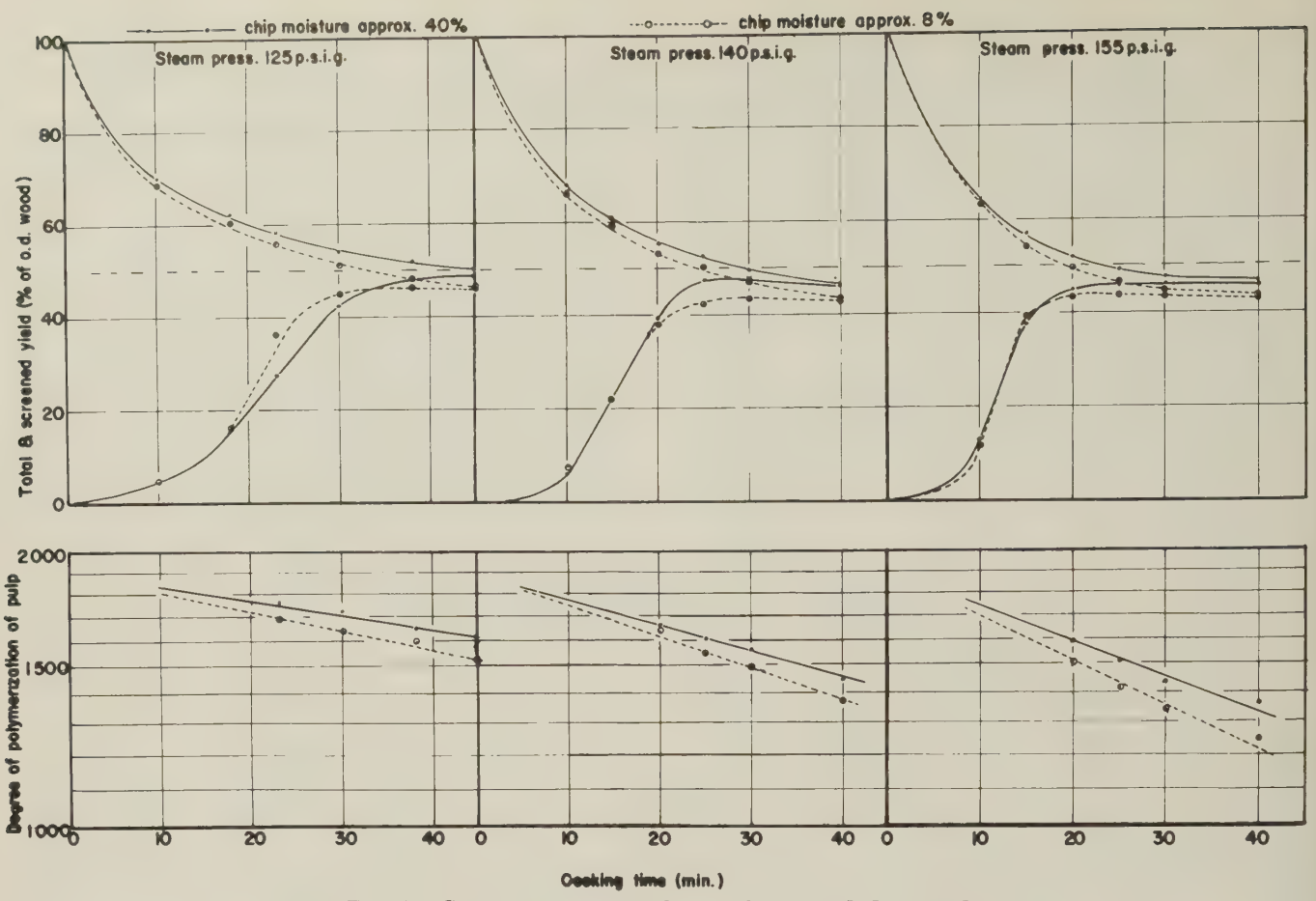
chip moisture approx. 40%
chip moisture approx. 8%
Steam press. 125 p.s.i.g.
Steam press. 140 p.s.i.g.
Steam press. 155 p.s.i.g.
Total ß screened yield (% of o.d. wood)
Degree of polymerization of pulp
Cooking time (min.)

Fig. 1. Continuous type pulping of wet and dry wood

Shredded slash pine—initial conc. 35 g.Na_2O per l., 25% sulphidity.

would be picked up by this procedure, it was a simple matter to calculate the required concentration of carbonate, bicarbonate, or sulphite to insure a definite percentage of impregnation of the salts.

In these pulping experiments, involving the impregnation of dry chips with water and with dilute salts, only one steam pressure, 140 p.s.i.g., was used. The results are tabulated in Table II and the cooking curves and D.P.-time relationships are shown in Fig. 2. In two instances, wet chips containing about 40% moisture were impregnated instead of the usual air-dry chips.

A final series of tests, involving batch-type cooking, was carried out. These tests involved wet and dry shredded chips alone. No impregnation studies were undertaken in this series. The cooking cycle involved 90 min. to reach the maximum steam pressure of 115 p.s.i.g. Cooking liquor of 51 g. Na_2O per liter was used, adding sufficient liquor to provide 16% Na_2O, on a dry wood basis. Sulphidity was 25%. The cooking data are listed in Table III and are shown graphically in Fig. 3.

DISCUSSION

Wet versus Dry Chips in Continuous Type Pulping

Figure 1 shows the cooking curves for the wet and dry shredded chips. The wet chips had dried out only slightly from their as-received condition, containing about 40% moisture. The air dried material contained about 8% moisture.

The screened yield data indicate that wet and dry chips cook at the same rate. The most reliable curves are those for 140 p.s.i.g. cooking pressure since all of the data points were obtained in duplicate and checked quite well. The data points for cooking wet chips at 155 p.s.i. were also obtained in duplicate. Therefore, these data are quite reliable. The screened yield curves at 125 p.s.i. show divergence early in the cook. In view of the very close agreement, wet versus dry chips, of the screened yield curves at 140 and 155 p.s.i., it may be assumed that this divergence at 125 p.s.i. can be accounted for by an error in the screened yield data at a cooking time of 23 min.

It appears that maximum screened yield is realized at the same time for both wet and dry chips. However, for any set of cooking conditions the maximum screened yield is lower for dry chips than for wet chips, by 2.5 to 4.0%. This would indicate more drastic cooking conditions for the dry chips, resulting in increased loss in carbohydrate. The loss in yield for the dry chips cannot be accounted for by increased delignification. An inspection of the pulp lignin contents in Table I shows that, for any specific cooking time, there are no significant differences in lignin content, wet versus dry chips.

One might argue that this increased degradation of the dry chips is due to higher concentration of alkali in the cooking liquor. If it is assumed that the moisture in the chips blends with the cooking liquor immediately on mixing, the concentration of alkali would be somewhat lower for wet chips than for the dry variety. With such an assumption and the liquor ratio and

moistures listed in Table I, the concentration after mixing chips and liquor would be 34.6 g. Na_2O per liter for the dry chips; 32.4% for the wet chips. Any such instantaneous mixing of liquor and chips is prohibited by the slow diffusion rates of the system. Further, any differences in concentration brought about by mixing would be too small to account for the loss in maximum screened yield suffered by the dry chips.

This loss in yield can be accounted for by a mechanism which is in agreement with the moving interface of reaction postulated by this laboratory. As the outer fibers of the chip become delignified they lose most of their protective coating (middle lamella) and the cellulose fibers come into direct contact with the cooking liquor. In those chips originally containing 40% moisture, the lumens of the fibers are about half full of liquid water while the lumens of the dry chips are empty. It is possible, in either case, for liquor to diffuse through the porous cell wall into the lumens, since the fibers have lost their lignin covering. In the case of the wet chips, the concentration of alkali inside the fibers will be reduced to one-half the value of the cooking liquor. In the dry chips, concentration in the lumens will be at the full cooking concentration since there is negligible moisture present to dilute it. Therefore, the degrading effect of alkali is much more pronounced for the dry chips and screened yields should be lower.

This degrading effect, if present, should be verified by the degree of polymerization of the pulps. The lines of degree of polymerization versus time, at the bottom of Fig. 1, show this to be true. At 25 min. cooking time, the D.P. numbers of the pulps from dry chips are 50 to 100 points lower than those from wet chips. As cooking time increases, these differences become somewhat greater.

These data point out the true importance of chip moisture in kraft pulping. This moisture does not, as has often been assumed, act as a diluent to the cooking liquor. Diffusion rates are so low that, even in slow, batch pulping, very little alkali can diffuse into the wood chip. Rather, moisture may be considered as a blocking agent against the entry of strong alkali into the porous cell wall when that cell wall becomes exposed to the cooking liquor. As the liquor penetrates the cell wall, if that cell wall and the lumen are already half full of water, the alkali in the liquor becomes diluted and is less active in its degrading effect.

The Effect of Reimpregnating Dry Chips with Water

Some of the dry shredded chips were reimpregnated with water and cooked under the same conditions as

Table II. Effect of Impregnants—Continuous-Type Kraft Pulping

Slash pine shredded chips, constant steam pressure of 140 p.s.i.g. and 25% sulphidity in all cooks

Cook no.	Chip moisture, % Before impreg.	Chip moisture, % After impreg.	Impregnant Type	Impregnant % Absorbed, wood basis	Cooking Liquor Initial conc. (g. Na_2O per l.)	Cooking Liquor Liquor ratio (g. liquor per g. O.D. wood)	Cooking Liquor % Na_2O	Cooking time, min.	Yield, % Total	Yield, % Screened	Analysis of screened pulp Lignin, %	Analysis of screened pulp Pentosan, %	Analysis of screened pulp D.P. no.
2855	7.0	56.6	H_2O	...	35.0	9.4	31.5	10	67.4	5.1	25.0	...	...
2856								15	59.7	17.6	19.3	...	...
2857								20	55.7	38.8	15.2	...	1609
2858								25	51.8	46.1	12.9	...	1584
2859								30	48.5	47.0	10.0	...	1509
2860								40	45.0	44.8	6.4	...	1419
2819	7.6	56.5	Na_2SO_3	3.6	35.0	9.3	31.4	10	65.3	6.2	22.4	...	...
2820								15	59.3	15.7	18.1	...	...
2821								20	53.9	32.8	14.9	...	1685
2822								25	50.7	42.6	12.3	...	1637
2823								30	47.9	44.6	9.8	...	1574
2824								40	44.5	44.1	6.3	...	1459
2831	7.5	56.2	Na_2SO_3	3.6	35.0	9.3	31.4	10	66.8	4.6	23.8	...	...
2832								15	60.7	13.3	19.5	...	...
2833								20	55.7	28.3	16.0	...	1680
2834								25	52.2	42.0	12.9	...	1624
2835								30	49.3	45.5	10.4	...	1584
2836								40	45.3	44.8	7.2	...	1503
2807	7.6	55.3	Na_2CO_3	3.0	35.0	9.3	31.4	10	66.1	5.6	23.6	...	...
2808								15	59.3	19.6	19.4	5.3	...
2809								20	54.2	35.8	15.2	...	1695
2810								25	50.1	44.7	11.6	...	1610
2811								30	48.4	45.7	9.9	...	1566
2812								40	44.6	44.2	6.5	4.8	1473
2837	8.1	55.7	Na_2CO_3	3.0	35.0	9.3	31.2	10	68.6	3.4	25.4	...	...
2838								15	60.0	16.1	19.2	...	...
2839								20	54.9	33.0	15.4	...	1597
2840								25	51.0	44.8	11.7	...	1584
2841								30	47.3	45.1	9.2	...	1536
2842								40	44.8	44.2	6.6	...	1414
2879	39.9	58.4	Na_2CO_3	3.6	35.6	8.2	28.3	10	66.3	6.9	20.4	...	...
2880								15	59.6	24.5	15.6	5.7	...
2881								20	54.9	40.7	12.7	...	1717
2882								25	51.5	47.0	9.5	...	1639
2883								30	48.3	46.5	7.6	...	1552
2884								40	46.2	46.0	4.8	5.0	1449
2885	40.9	57.2	$NaHCO_3$	5.1	35.6	8.1	27.7	10	66.3	8.3	19.6	...	...
2886								15	57.8	25.6	15.8	...	...
2887								20	54.2	44.3	12.1	...	1706
2888								25	50.5	47.1	9.3	...	1602
2889								30	48.6	47.2	7.5	...	1563
2890								40	46.5	46.2	10.1	...	1442

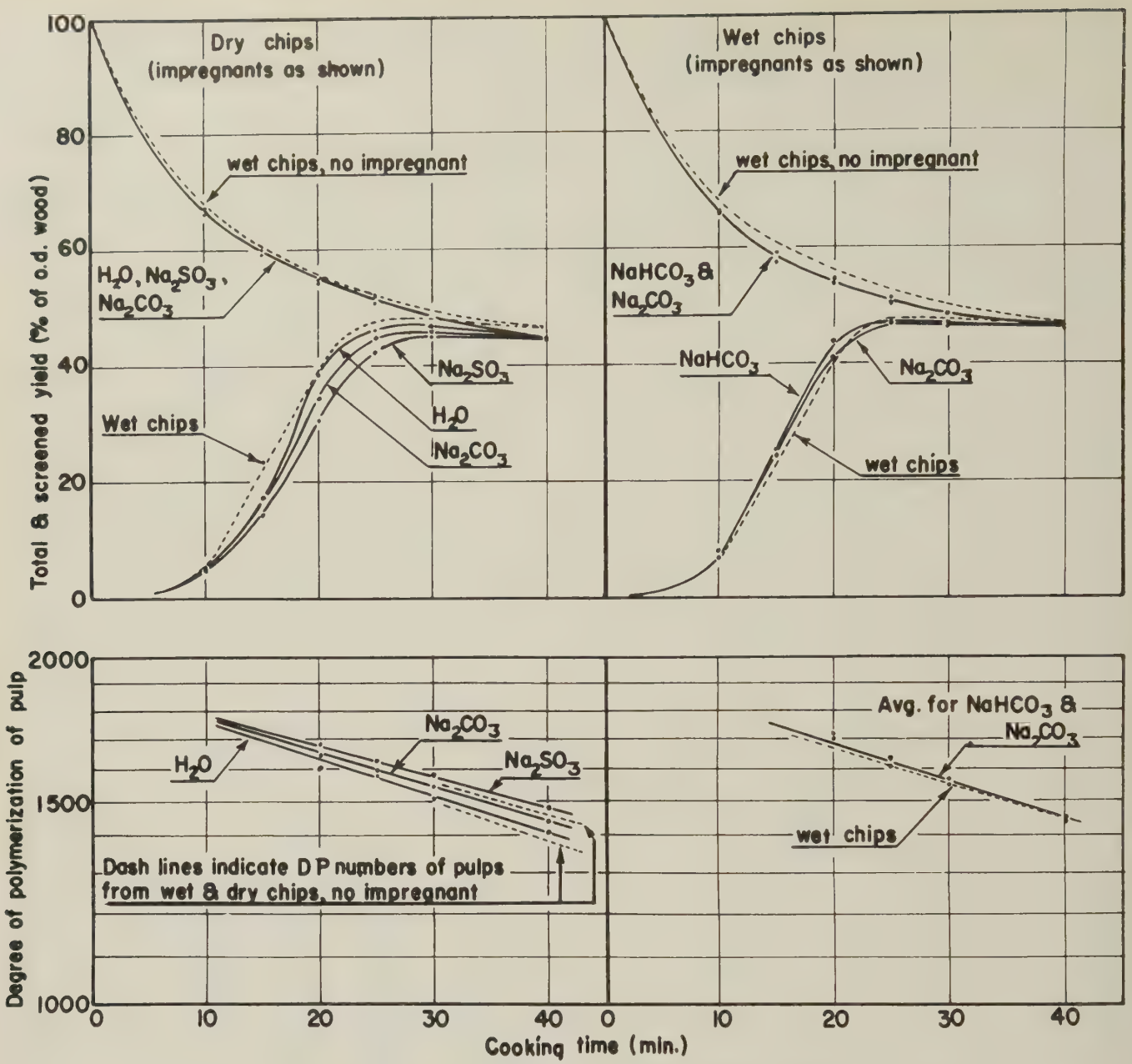

Fig. 2. Effect of impregnants—continuous type kraft pulping

Slash pine shredded chip, initial conc. 35 g. Na_2O per l., 25% sulphidity, const. steam press. 140 p. s. i. g.

the wet and dry chips just discussed. The data are reported in the first part of Table II, as cooks nos. 2855 through 2860. The reimpregnation procedure brought the moisture content from the original value of 7.0 to 56.6%, considerably higher than the 40% in the wet chips.

A comparison of the screened yields for these cooks to the corresponding yields for cooks nos. 2861 through 2866 and 2891 through 2896 (Table I) shows that the reimpregnated chips cooked at the same rate and reached the same maximum screened yield as the wet chips. This is borne out by the cooking curve in Fig. 2. A comparison of the lignin contents of the pulps indicates that the pulps from the reimpregnated chips might have a lignin content about 1.0 to 1.5% higher than for the wet chips but it is doubtful if this difference is enough to be significant.

The D.P. numbers for the pulps from reimpregnated chips are slightly lower than for the wet chips but not as low as those resulting from the pulping of dry chips. The decrease in D.P. number is about 30 to 40 points in the range of 1500 to 1600 D.P. number. It would be necessary to repeat this series of experiments once or twice to see whether this small difference actually exists or whether it is within the limits of error in viscosity measurement. Even if reimpregnated pulps actually are 30 to 40 points lower in D.P. number than the corresponding pulps from wet chips it is doubtful that such differences are significant in judging pulp quality.

On a basis of the comparative tests it would appear safe to state that dry chips, if reimpregnated with water before cooking, can be returned to the same condition as the original wet chips, from a pulping standpoint. Such a statement is, of course, valueless to pulp mill operations since chips have little opportunity to dry out before being cooked. However, it could be valuable in laboratory work. Most laboratories cannot store

wet chips for extended periods of time. Mold and rot occur very rapidly, to the point that the wood constituents may be seriously altered. If the chips can be air dried when received they can be stored for long periods without change. The reimpregnation procedures described here are very simple and require little time to accomplish. As wood is taken from dry storage, several samples could be reimpregnated either the day before or on the same day that the samples are to be cooked. The data presented here indicate that the results would be just as reliable as if the chips had been cooked immediately after chipping.

Such a procedure of drying and reimpregnation with water is also a definite advantage from a standpoint of accuracy. When logs are brought into the mill after a prolonged rainy season and are chipped without extended yard storage, the chips may contain 50 to 53% moisture. It is almost impossible to accurately evaluate the moisture content of small quantities of chips under such circumstances. It has been found necessary in this laboratory, on occasions where extremely wet chips were involved, to repeat a series of cooks three or four times in order to obtain a reasonably trustworthy yield curve. The system of drying and reimpregnating chips with water has been found to be highly advantageous, particularly when large, mill size chips are involved.

The Effects of Preimpregnation with $NaHCO_3$ Na_2CO_3, and Na_2SO_3

In the first section of the discussion it was pointed out that the chip moisture probably remains in the fibers themselves until sufficient middle lamella lignin has been removed to permit easy access of the cooking liquor to the porous fibers. The question naturally arises as to whether this water, during the first 15 or 20 min. of the cook, might not become low in pH because of the formation of wood acids at the elevated temperatures involved. Under such circumstances, acid hydrolysis might take place within the fiber, resulting in reduced D.P. number of the cellulose and loss of pentosan. It was mainly to answer this question of whether or not acid hydrolysis is taking place during the cook that this phase of the investigation was undertaken.

Dry shredded chips were preimpregnated with a solution of sodium carbonate. Other batches of dry chips were impregnated with sodium sulphite. Concentrations of the solution were adjusted so that about 3.0 to 3.5% of salt (wood basis) would be absorbed during the impregnation. In addition, wet wood chips were also preimpregnated, some with sodium carbonate, others with sodium bicarbonate. In each case, six batches of chips were impregnated, using sufficient weight of chips in each batch for a single cook. All chips were cooked at a constant steam pressure of 140 p.s.i.g., all other conditions duplicating, as nearly as possible, those used in the previous cooks. The cooking data are reported in Table II and are shown graphically in Fig. 2.

The screened yield curves, when compared to the results for wet wood, indicate a very slight falling off in rate of pulping and a slightly decreased maximum screened yield when sodium carbonate is impregnated into the dry fibers. A further loss in rate and maximum yield took place when sodium sulphite was used. The differences in total yields from these cooks, however, as compared to the yields from wet chips, were quite insignificant. The dotted cooking curves in Fig. 2 are a reproduction of the curves for wet chips cooked at 140 p.s.i., taken from Fig. 1, and are used as reference curves for the new data.

The deviations of the screened yield curves for the carbonate and sulphite impregnated from the corresponding curve for wet wood are not great. In each case, however, the data are the result of averages from two sets of cooks, each set agreeing quite closely with the other. Furthermore, the data plot very well along a smooth curve. It would appear that these decreases in screened yield, brought about by the addition of carbonate and sulphite solutions to the dry chips, are real decreases in yield rather than accidental errors characteristic of the pulping routines. The cause of this loss in yield is open to conjecture.

It was thought, at first, that this loss in yield might be due to a dissolving of pentosan by the alkalinity inside the fiber. However, a check on the pentosan content of cooks nos. 2880 and 2884 showed a pentosan percentage of 5.73 and 4.95, respectively. These percentages agree very closely with those for similar cooks using wet wood, dry wood and dry wood which had been reimpregnated with water. There is so little pentosan present, in any case, that all traces of pentosan would have to be removed to account for the loss in yield.

It is quite doubtful that the loss in screened yield can be accounted for by degradation and dissolution of cellulose. An inspection of the D.P. number-time relationships at the bottom of Fig. 2 bears this out. The D.P. numbers for the screened pulps from the sulphite impregnated were the highest of all the preimpregnated cooks, while this series suffered the greatest loss in yield.

A contradiction to this yield loss becomes apparent when one examines the screened yield curves for wet chips which had been preimpregnated with carbonate and with bicarbonate, shown at the right of Fig. 2. Here there is no screened yield loss, both of the curves being so close to the curve for wet chips as to be considered identical to it. Why this loss occurred when the alkaline salts were added to the dry chips but did not take place when wet chips were used cannot be explained. The losses may possibly be due to unavoidable errors characteristic of the pulping routine but the trend is so regular as to make such a possibility doubtful.

In any event, the data for the whole series of experiments indicate rather definitely that no measurable acid hydrolysis takes place at the center of the chip before the alkali reaction reaches there.

Wet versus Dry Chips in Batch-Type Pulping

The final phase of the study showed the effect that drying of the shredded chips had on pulping under batch conditions similar to those used in mill practice. In these tests 90 min. was allowed for the digesters to reach the maximum steam pressure of 115 p.s.i.g. An initial concentration of 51 g. Na_2O per liter was used, adding sufficient liquor to provide 16% Na_2O on a

Table III. Effect of Chip Moisture—Batch-Type Kraft Pulping

Slash pine shredded chips—max. steam press. 115 p.s.i.g., 90 min. to max. pressure—25% sulphidity in all cooks

Cook no.	Moisture in chips, %	Cooking liquor: Initial conc. (g. Na_2O per l.)	Cooking liquor: Liquor ratio (g. liquor per g. O.D. wood)	Cooking liquor: % Chem. as Na_2O	Total cooking time, min.	Yield, %: Total	Yield, %: Screened	Analysis of screened pulp: Lignin in screened pulp, %	Analysis of screened pulp: Pentosan	Analysis of screened pulp: D.P. no.
2903	40.6	51.1	3.3	16.0	70	65.0	2.4	21.5	...	...
2904					80	61.8	6.9	17.8	7.3	...
2905					90	57.7	24.0	14.9	...	1929
2906					100	54.2	44.6	12.5	...	1839
2907					110	51.4	50.7	9.8	...	1775
2908					120	49.2	49.2	7.7	7.2	1718
2909	8.3	51.1	3.3	16.0	70	65.3	2.8	22.3	...	...
2910					80	60.2	7.8	20.2	7.6	...
2911					90	55.5	23.1	15.9	...	1792
2912					100	51.5	46.2	12.4	...	1737
2913					110	49.5	48.9	10.0	...	1688
2914					120	46.8	46.8	7.2	7.5	1647

dry wood basis. This corresponds to a liquor-wood ratio of 3.3:1, excluding moisture in the wood. The cooking data for wet and dry chips are listed in Table III and are shown graphically in Fig. 3.

The data and cooking curves show, as in continuous cooking, that rate of pulping was unaffected by chip moisture but a definite loss in maximum screened yield occurred in the case of dry chips. About 2.0% loss in yield was incurred by using dry chips. This loss was accompanied by a corresponding loss in D.P. number in the screened pulp, amounting to about 80 points. This loss in quality is not serious but is, nevertheless, definite.

The behavior of the wet and dry chips under batch cooking conditions is almost identical to that found for continuous-type pulping. It is apparent that chip moisture does not affect the active concentration of alkali in the liquor. If moisture in the chip were included in calculating the initial concentration of alkali, that concentration would be only 42.1 g. Na_2O per liter in the case of wet chips, 49.8 g. per liter in the dry chips. The data show that pulping rates, as indicated by screened yields, are identical for wet and dry chips, indicating that the same concentration is in effect in both cases.

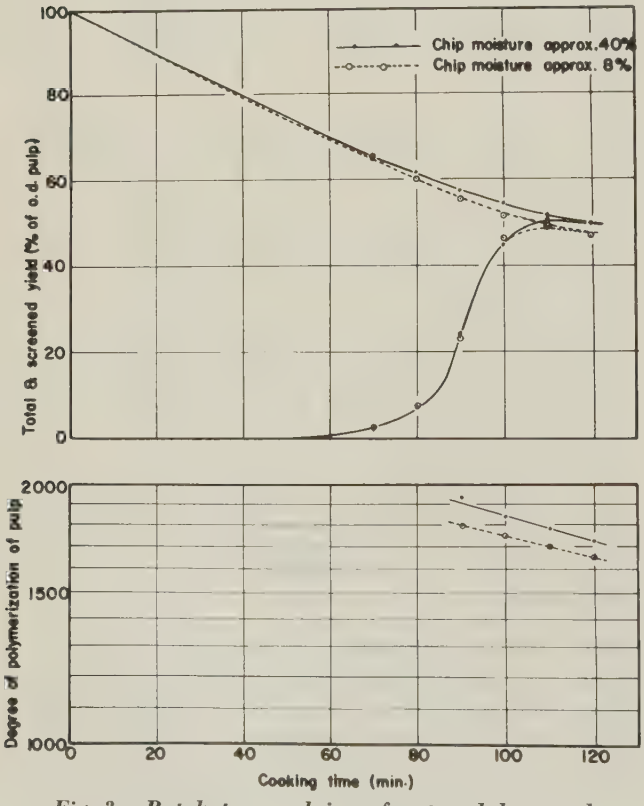
Chip moisture approx. 40%
Chip moisture approx. 8%
Total & screened yield (% of o.d. pulp)
Degree of polymerization of pulp
Cooking time (min.)

Fig. 3. Batch-type pulping of wet and dry wood

Shredded slash pine, 90 min. to max. press. of 115 p.s.i.g., initial conc. 51 g. Na_2O per l., 25% sulphidity

No experiments were carried out in batch pulping using dry chips which had been reimpregnated with water. The behavior of the wet and dry chips under batch conditions was so similar to that found when continuous-type pulping was employed that it was felt such tests would be unnecessary. It seems safe to assume that the reimpregnated chips would respond to the pulping conditions in a manner very similar to the original wet wood.

The pentosan content of the pulp is not affected by the moisture in the original chips. The pulps contained about 7.5% pentosan for both wet and dry chips. This value is the same as would be obtained from mill size chips in either laboratory or commercial digesters. It should be noted that this 7.5% is much higher than the 4.5 to 5.0% that results from continuous type pulping. This difference is characteristic of the two systems. The lower pentosan content from the continuous-type operation is caused by the combination of high temperature and relatively high initial concentration always encountered in continuous pulping. In batch pulping, when maximum temperature is reached the concentration of alkali in contact with the chips has dropped to about one-third the initial concentration. This decreased concentration is favorable for retention of pentosan in the pulp.

The extremely high screened yield and pulp quality resulting from the batch pulping of the wet shredded chips should be noted. A maximum screened yield of 50.7%, with an average D.P. number of 1775 was realized in a total cooking time of 110 min. The lignin content of this pulp was about 10%. This yield value is expressed as pounds oven-dry fiber per 100 lb. oven-dry wood, not in the usual mill terms of pounds air-dry fiber per 100 lb. oven-dry wood.

This extremely high yield and quality cannot be realized in commercial size digesters. In the laboratory digesters, temperature is constant at all points in the digesters and mixing of chips and liquor is uniform because of the rotation of the digesters. In the large

vertical digesters used in practice, mixing of liquor and chips is poor, channeling occurs, and the usual direct steaming results in wide variations in temperature. However, such yields and quality can be approached if shredded wood is used instead of the usual large chips. The shorter the temperature rise period employed, the greater the improvement. If temperature rise periods of 2.0 hr. or more are used it is doubtful that shredding will offer any advantage.

As a matter of interest to those concerned with high-speed continuous kraft pulping, the data in Table I and Fig. 1 show the effect of steam pressure on cooking time, yield, and quality. A steam pressure of 125 p.s.i.g. will produce a pulp with 48.5% screened yield and a D.P. number of 1600 in 45 min. As steam pressure is raised to 140 p.s.i., cooking time is reduced to 25 to 30 min., screened yield is about 47.5% with a D.P. number of about 1600. At 155 p.s.i., cooking time is about 25 min., screened yield about 45.5% and D.P. number about 1500. It is felt that, if steam pressure, initial concentration, and liquor ratio are adjusted to achieve maximum screened yield in 35 min., a yield of about 48% and a D.P. number of about 1700 can be realized.

CONCLUSIONS

In summing up, the results of these experiments may be condensed in the following brief statements.

1. Air-dry chips, in kraft pulping, will cook at the same rate as moist chips but are lower in maximum screened yield by 3.0 to 4.0%.

2. Dry chips can be impregnated with water, returning them to such a condition that they will respond to kraft pulping in a manner similar to the original green chips.

3. Moisture in chips does not act as a diluent to the cooking liquor to make the cooking conditions milder but, rather, acts as a blocking agent in the fibers to prevent undiluted cooking liquor acting on the fibers when delignification is sufficiently complete to expose the porous fibers.

4. Preimpregnation of the chips with dilute alkali, such as sodium bicarbonate, sodium carbonate, or sodium sulphate does not produce beneficial results. The results of these tests show, by inference, that in normal pulping no acid hydrolysis occurs in the fibers at the center of the chip before the cooking reaction has reached that point.

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Steam Generators Designed for Multiple Fuel Firing

MAX O. FUNK

The pulp and paper industry has pushed the gains that suspension burning of bark has made possible. Today the industry uses power boilers that fire bark in combination with coal, oil, or gas. These boilers achieve availabilities that make them highly reliable steam producers.

THE advent of turbulent suspension burning of bark, as thoroughly described in papers already published,* has made possible the design of bark burning boilers with high availability and use factors as well as high over-all efficiency. This has changed the basic concept of boiler applications in the pulp and paper industry. Formerly, bark was a waste material to be disposed of as painlessly as possible; now it is a dependable source of energy. Formerly, bark burning was restricted to separate boilers; now it can be combined with other fuels in a bark-power unit. Formerly, a basic boiler plant in a paper mill required three types of boilers; now it is feasible to use only two.

Naturally, there are limits within which this new concept of multiple fuel furnaces can be applied. These are defined by load characteristics, extent of bark preparation and regulation, proportions of various fuels to be burned, characteristics of the alternate fuels, and size of unit. Some of these limits are interrelated, and this paper will describe several modern applications of multiple fuel units and how these limitations affect their design. Each of these installations is worthy of its own paper, but within the limits of time available here, this paper can only briefly summarize the features of each one.

Beginning with the smallest, Fig. 1 illustrates a unit for bark and coal for the following conditions: maximum continuous evaporation—55,000 lb. per hr., pressure—150 p.s.i.g., final steam temperature—520°F. It includes a two-drum, integrated boiler, an extended refractory furnace with a spreader stoker, a superheater, and an air heater. It is capable of generating full design capacity on bark, coal, or any combination of the two. The coal and bark feed rates are separately controlled by separate rotary feeders, and the discharge from the feeders is mixed in chutes leading to the distributors mounted on the front wall of the furnace. Both the coal and bark feeders are equipped with variable speed drives which can be actuated by automatic combustion controls.

The rotary bark feeder illustrated here is limited to a hogged product and can tolerate only a small storage above it. Consequently, the conveyor arrangement to these feeders must be capable of providing bark as required. Properly arranged, this combination of equipment will allow automatic operation for the full range of boiler evaporation on either fuel or any proportions of them without bark storage at the boiler.

MAX O. FUNK, Combustion Engineering, New York, N. Y.

* "Suspension Burning of Bark Refuse," by Robert Ellwanger, The Chesapeake Corporation of Virginia, West Point, Va. "Turbulent Suspension Burning of Wet Wood, Bark and Other Fuels," by Otto de Lorenzi, Combustion Engineering Inc., New York, N. Y. "Some Aspects of Burning Wood Waste by Spreader Stoker," by Conant Dodge, H. A. Smyth, and L. R. Guthrie, Weyerhaeuser Timber Co., Tacoma, Wash.

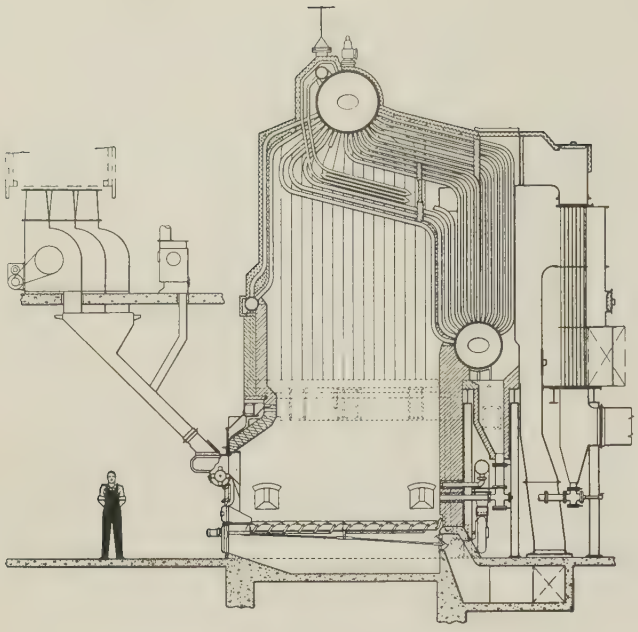

Fig. 1

Before considering a unit of this type, a careful study of the ash from both coal and bark should be made. This study should include a determination of fractional ash fusion temperatures. Figure 2 illustrates the results of one fractional ash analysis. The curves have a rising characteristic between the two extremes of 100% coal ash and 100% bark ash, and the coal and bark from which the samples were taken are acceptable for simultaneous firing on a stoker.

At this point, it would be well to look at the results

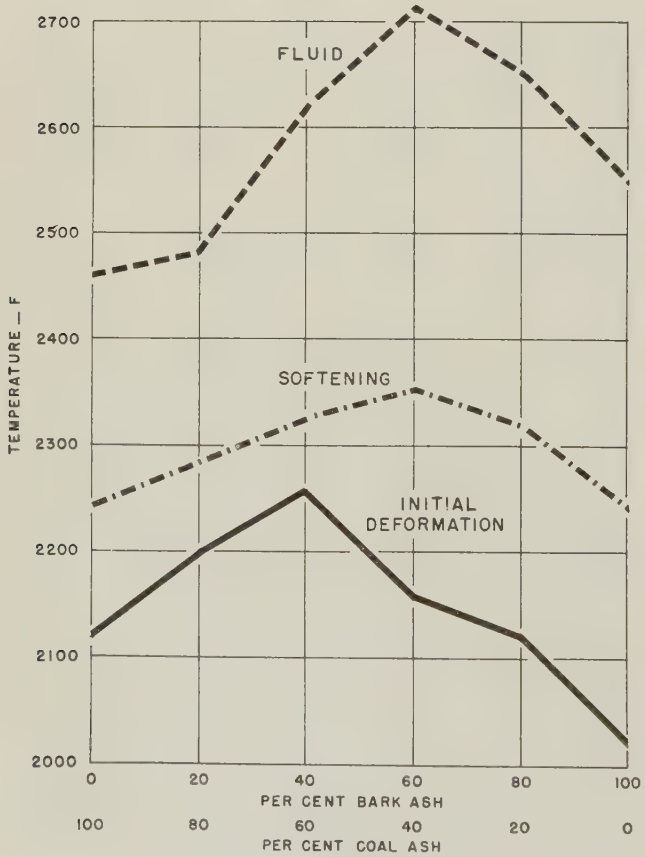

Fig. 2. Fractional ash analysis

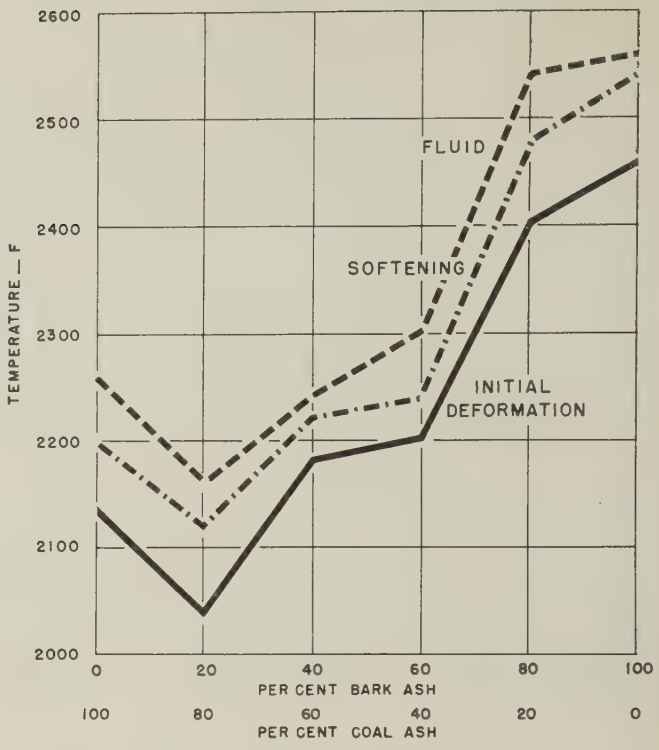

Fig. 3. Fractional ash analysis

of another fractional ash analysis which was made from samples of coal and bark which would be doubtful for this type of simultaneous firing. Figure 3 illustrates these results. The lowest points on the curves appear for a mixture of 20% bark ash and 80% coal ash, and the softening and fluid temperatures are only 50°F. apart at this point. A furnace more suitable for these fuels will be discussed later. The contrast between these two curve patterns emphasizes the importance of carefully considering ash properties when coal and bark

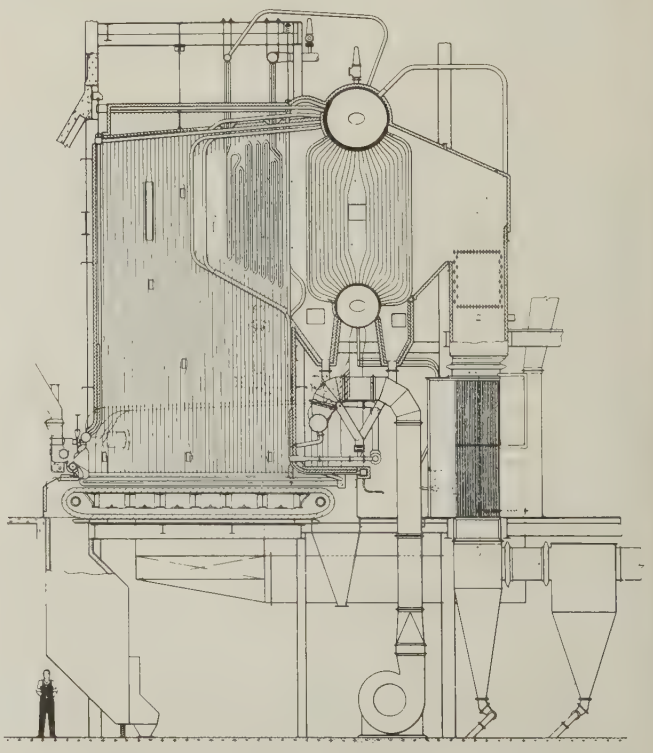

Fig. 4

are to be mixed in a common furnace. These properties have a pronounced effect on grate performance, furnace cleanliness, slagging in boiler and superheater passes, availability, and use factor.

Figure 4 illustrates a unit for bark and coal for the following conditions: maximum continuous evaporation—120,000 lb. per hr., pressure—615 p.s.i.g., and final steam temperature—750°F. It includes a two-drum boiler, fully water-cooled furnace, spreader stoker, superheater, economizer, and air heater. Coal is metered and fed into the furnace through standard coal spreader units mounted on the front wall, and bark is fed into the furnace through a pneumatic distributor mounted on one side wall. Although the average hourly bark quantities are only enough to generate 20% of the total steaming capacity, the rate of bark feed without regulation is sometimes high enough to automatically reduce the coal feed to zero.

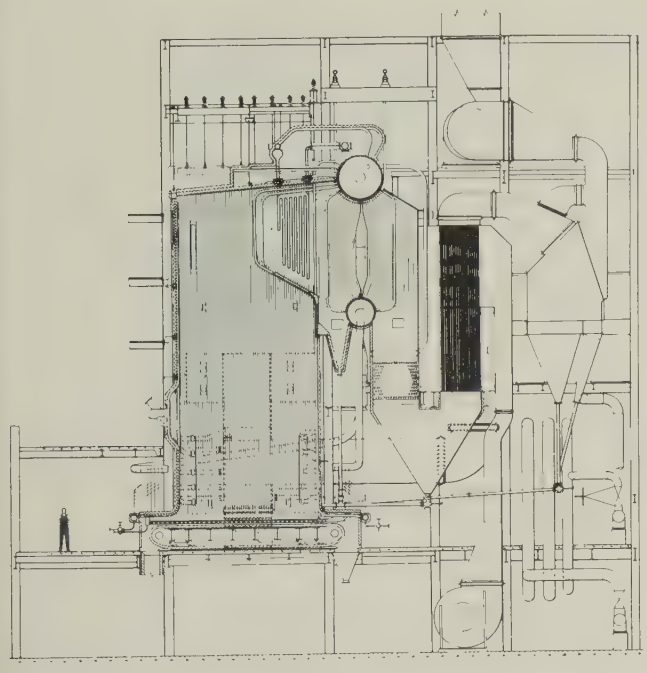

Fig. 5

This arrangement of equipment is particularly suited for medium size boilers where coal is the base fuel, and the proportions of bark to coal are low. The unit can handle hogged or unhogged bark with a regulated or unregulated feed within the limits of the range of steam demands.

Figure 5 illustrates a unit for bark, coal, oil or gas for the following conditions: maximum continuous evaporation—200,000 lb. per hr., pressure—625 p.s.i.g., and final steam temperature—750°F. It is capable of generating full capacity on coal, oil, natural gas or any of these fuels with 40,000 lb. of bark per hr. It includes a two-drum, single pass boiler, fully water-cooled furnace with tangential burners for oil or gas and a high set spreader stoker for bark, superheater, economizer, and air heater. A decantation-type dust collector was used to classify fly-ash carry-over . . . particularly for coal firing.

Bark or coal are fed into the furnace through the distributors of the high set spreader stoker. Oil or natural gas are fed into the furnace through tangential burners located in the side walls at an elevation above the distributor. Coal is metered through rotary feeders, but in this application the rate of bark feed is uncontrolled. Other boiler equipment and load characteristics allow high loading of this unit. Consequently, the bark flow can vary from maximum to minimum, and the alternate fuel will make up whatever difference is necessary. This can be accomplished automatically with an adequately designed combustion control system. It should be remembered that controls for any unit which will burn bark at uncontrolled rates must be capable of adjusting for the widest fluctuations of wood room operation and that these variables must be absorbed within the range of steam demand on the bark-power unit.

To achieve a controlled steam temperature with the unit shown in Fig. 5, the superheater metals were chosen for the highest uncontrolled steam temperature which would result from peak load operation with any combination of the four fuels involved. The steam from the outlet header of the superheater passes through a spray-type desuperheating station which takes water from a small condenser which serves this purpose exclusively. The condenser is a tubular heat exchanger which takes steam from the drum, uses feed water on its way to the economizer as a coolant, and prepares condensate for the desuperheater. This arrangement of equipment was designed for a controlled steam temperature of 750°F. from an evaporation of 150,000 lb. per hr. to a peak of 240,000 lb. per hr. regardless of the combination of fuels fired.

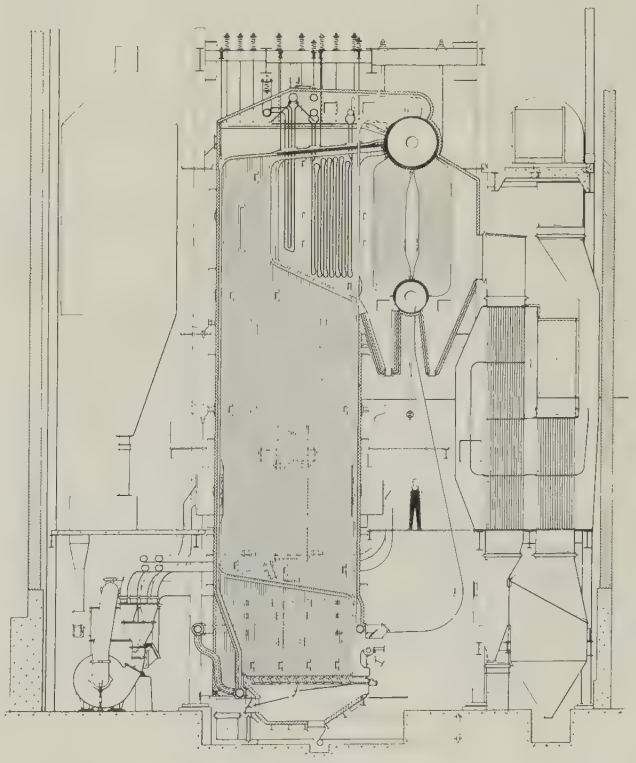

Fig. 6

When choosing a boiler in the range of 200,000 lb. per hr. and above for coal in combination with bark, there are two basic coal-firing methods which can be con-

sidered...stoker or pulverized coal. An economic study will generally dictate the choice of one or the other. In areas where fuel costs are high, the higher efficiencies which are realized with pulverized coal will generally offset higher first cost. Conversely, in areas with low fuel costs, lower first cost of the stoker unit will generally offset the lower efficiencies. Other conditions, such as use factor, power costs, and proportions of fuels to be burned will also affect this choice of basic firing method.

Figure 6 illustrates a 200,000 lb. per hr. unit for pulverized coal and bark. Steam conditions are 875 p.s.i. and 825°F., and a peak of 220,000 with coal and 30,000 lb. per hr. of bark is possible. The unit includes a two-drum, single pass boiler, fully water-cooled furnace with tangential burners for pulverized coal and a dump grate spreader stoker for bark, two-stage superheater, and two-section air heater.

The ash quantities and physical characteristics in this case allow mixing of the ash in a common furnace with simultaneous firing of coal and bark. However, the low ash content of the bark allows the use of dumping grates rather than moving grates on the stoker. To stay within the temperature limits of low alloy grate materials, air to the plenum chamber under the grates is taken from a point ahead of the last air pass through the air heater. Higher air temperatures are used for the tangential air jets in the lower portion of the furnace and for the pulverized coal system.

Steam temperature control is achieved with vertical burner tilt and with a spray desuperheater using condensate from its own condenser. This arrangement makes possible a control range at constant steam temperature from 140,000 to 220,000 lb. per hr. The predicted load characteristics are such that regulated bark feed is essential. Consequently, the bark is

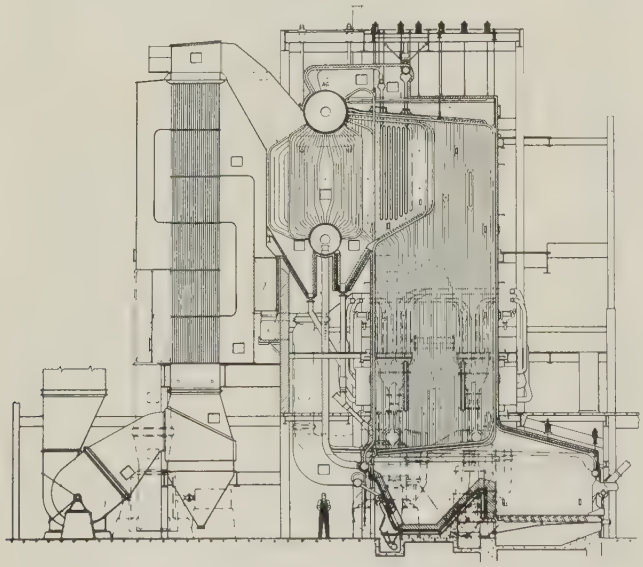

Fig. 7

hogged and a small live bottom bin is located immediately in front of and above the bark distributors.

Another unit for similar conditions but with different fuels is shown in Fig. 7. It is designed for 200,000 lb. per hr. when burning coal alone or in combination with 38,000 lb. per hr. of bark. Steam conditions are 540 p.s.i. and 700°F. The unit includes a two-drum, single pass boiler, fully water-cooled furnace with tangential burners for pulverized coal and a dump grate spreader stoker for bark, superheater, and air heater.

On this job, coal and bark characteristics were such that it was decided to arrange the stoker in such a way

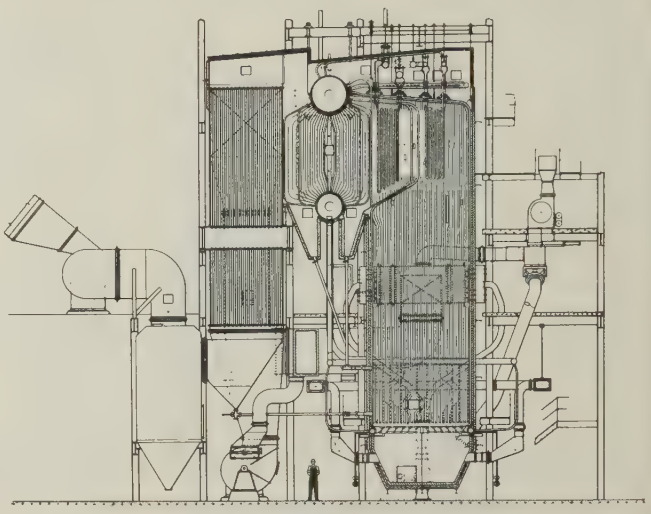

Fig. 8

as to preclude coal ash mixing with bark ash on the grate. Therefore, the stoker was arranged in an extension of the pulverized coal furnace. Over-fire air is introduced through the rear wall of the dutch oven and also through the lower rear wall of the pulverized coal furnace. This latter air supports the burning of carbon which carries over from the stoker and tends to stay in the pulverized coal furnace bottom. This arrangement of air eliminates large accumulations of material in this area and simplifies coal ash removal.

Two considerations dictated the amount of wood preparation on this job. One was the predicted load characteristic, and the other was the problem of conveying bark for a distance of 3000 ft. The predicted steam loads required a regulated feed of bark to the furnace, and the decision to use pneumatic conveying dictated hogging of the bark.

Although any of the types of units already discussed could also be arranged to burn oil or natural gas, we have not thus far considered a unit designed exclusively for fluid fuels and bark. Two examples to satisfy widely different plant conditions will follow.

The first is shown in Fig. 8. This unit is capable of producing 200,000 lb. per hr. at 880 p.s.i. and 830°F. when burning oil or natural gas separately or in combination with 14,000 lb. per hr. of bark. The unit includes a two drum, single pass boiler, a full water-cooled furnace with tangential burners for oil, gas or bark, a water-cooled hopper bottom with a dumping grate for burning residual bark, a two-stage, radiant and convection superheater, and a two-section air heater.

Since the bark proportions are comparatively small, a new approach to its turbulent suspension burning was used. The bark is hogged and metered with a screw bottom bin near the wood room. It is brought to the boiler room on a belt conveyor which discharges into a small rotary bark feeder. There is very little storage

at this point...just enough to act as a seal between outside air and the bark burning system. The bark flow is split into two streams as it leaves the feeder, is mixed with preheated air, and flows to the inlets of two exhausters. The effluent from each exhauster is again split with each steam going to a tangential burner at a corner of the furnace. From the time the bark and

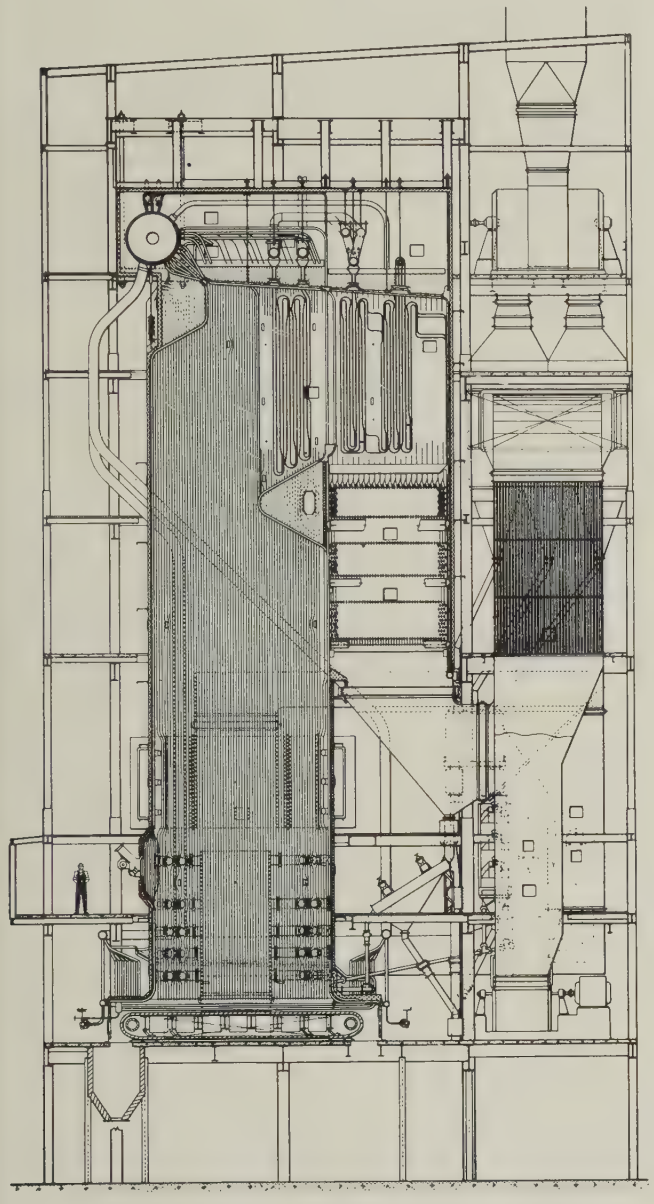

Fig. 9

preheated air are mixed at the rotary feeder outlet until the mixture is introduced at the four corners of the furnace, predrying is taking place. Therefore, most of the bark is burned in the burner area, and only a small amount will drop to the furnace bottom. This bottom is equipped with a 3-ft. wide dumping grate. The residual bark is burned at this point, and the resulting ash is periodically dropped into the ash pit.

Although this unit was designed for only 14,000 lb. per hr. of bark, it has burned up to 25,000 lb. per hr. without any difficulty.

A unit to burn fluid fuels and bark to meet the other extreme of design conditions is shown in Fig. 9. As far as we know, the furnace on this unit can burn more bark than any other single furnace that has ever been built. Design conditions are: 600,000 lb. per hr. with natural gas, 450,000 lb. per hr. on a mixture of natural gas and bark, 1335 p.s.i., and 958°F.

This is a radiant-type unit with only one drum, a fully water-cooled furnace with tangential burners for fluid fuels and a high set spreader stoker for bark, a two-stage superheater with a spray desuperheater between stages, an economizer, and dual air heaters.

The maximum burning rate of bark was predicted to be 140,000 lb. per hr., but the maximum rate in actual operation has been 202,000 lb. per hr. The bark is not hogged and its flow is not regulated. Steam demands in this plant allow high base loading of this unit, and the extremes of wood room operation can be absorbed by either fluid fuel.

Bark is proportioned to the high set distributors by the natural frequency conveyor shown in Fig. 10. The flow from the bark chute to this proportioner is very erratic, but the bark levels out in the first 11 ft. before it drops into five partitioned sections. It then falls through four bottom openings and an end discharge into chutes leading to the five distributors. The continuity of flow into the partitioned sections contributes to exceptionally stable furnace conditions for bark burning. There is no puffing in the furnace at any elevation even though the bark flow rate varies from zero to 200,000 lb. per hr.

Variable flow rates of this magnitude, in very short periods of time, impose a heavy burden on control equipment. However, a well-integrated control to meet these conditions can be designed with cooperative planning by the user, control manufacturer, and boiler manufacturer. In this case, the control of steam temperature is accomplished by vertical burner tilt and a

Fig. 10

steam assist, spray type desuperheater between stages of the superheater. Other control requirements for multiple furnaces will be discussed in another paper.

Fly ash carry-over, its collection, and its disposal have not been mentioned in the discussion of each individual unit since it is a problem common to all bark burning. Proper turbulent suspension burning

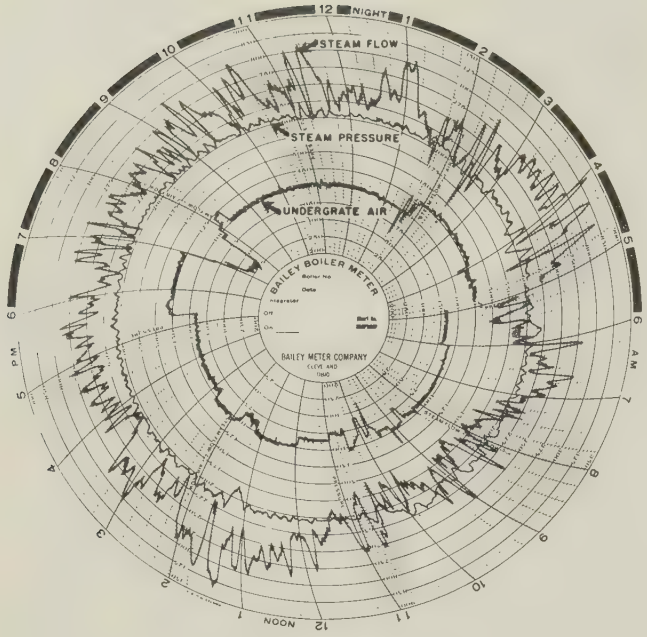

Fig. 11. No. 2 power boiler 6/19/58

reduces the initial carry-over from the furnace, but control of stack emission requires the separation of the fly ash from the products of combustion before they can be discharged to the atmosphere. The choice of the method of disposal of the collected material will vary from job to job; but in general, where bark burning is involved, it is advantageous to classify the collected material. Analysis of fly ash carry-over will usually result in a favorable fractional combustible variation with the size of the particle. Larger sizes will be high in combustible, and the smaller will be low in combustible. To avoid high recirculating loads of noncombustible dust in the boiler passes, it is desirable to screen this material from the total catch and to dispose of it without returning it to the furnace. . . The

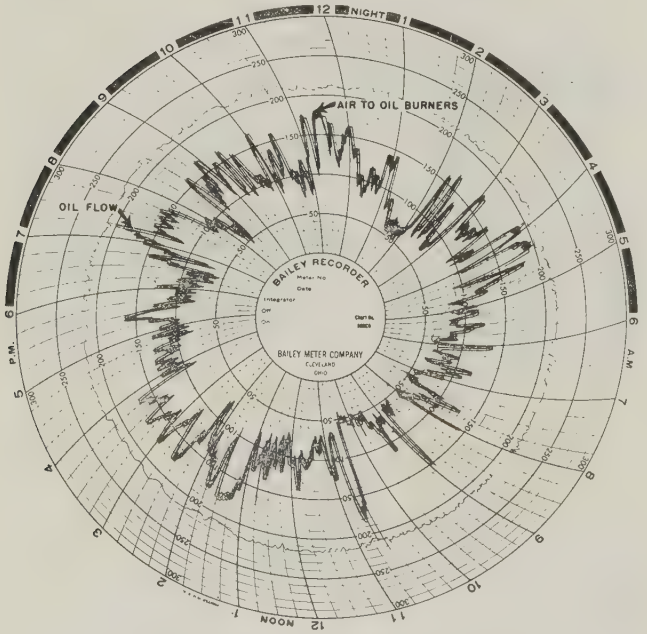

Fig. 12. No. 2 power boiler 6/19/58

balance of the material which is higher in combustible can be returned to the furnace and a significant gain in efficiency realized on those units where bark is a large proportion of the total fuel.

Results of actual operation of boilers designed for multiple fuel burning can best be illustrated with typical charts from recording instruments. Charts for units which burn hogged bark at regulated rates of flow have been published in the papers mentioned in the early part of this paper. Figures 11, 12, and 13 represent day-to-day performance of the unit shown in Fig. 5. Although it was designed for a maximum continuous evaporation of 200,000 and a peak of 240,000 lb. per hr. on coal, the steam flow chart shows peak stream flows up to 340,000 on bark and oil. The chart shows an extremely erratic steam flow, but steam pressure is controlled within close limits. . . even though bark flow is uncontrolled. Oil flow and air-to-oil automatically adjust for changes in steam flow and bark flow. Con-

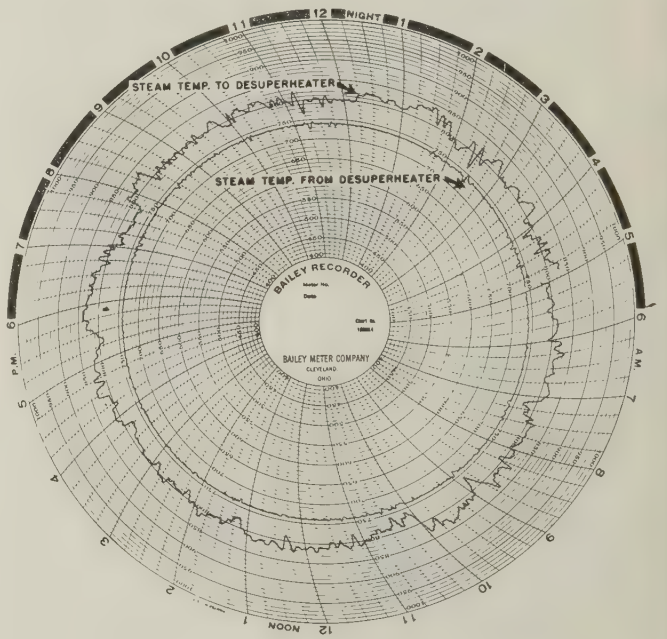

Fig. 13. No. 2 power boiler 6/19/58

sequently, the oil flow is even more erratic than the steam flow. Despite the fluctuations in burning rates and steam demand, the final steam temperature is controlled within $\pm 10°F$. This is truly remarkable performance.

The turbulent suspension burning of bark in combination with other fuels has been illustrated by each of the examples discussed in this paper. There is a specific approach to each individual plant's conditions, and with thorough consideration of all the factors involved, there need be no question of successful operation. However, any one of these units is not a universal approach for any set of specified conditions and fuels. Some features may be common to all units for this type of service, but there can be no compromise with a thorough evaluation of each feature against individual plant requirements.

Presented at the Thirteenth Engineering Conference of the Technical Association of the Pulp and Paper Industry, Portland, Ore., July 28–Aug. 1, 1958.

Steam Generators for Multiple Fuel Firing

E. A. KAZMIERSKI

The paper describes the components of a simple oil burner, progressively adding elements for gas and pulverized coal to show a multifuel burner. Furnace requirements for each of these fuels is discussed. Bark or wood firing is introduced and its effect on overall design of the steam generator described. The use of pile burning and spreader stokers for firing bark in combination with oil, gas, and coal, is shown in typical units. Finally, cyclone firing for all these fuels is developed and illustrated with typical jobs.

STEAM generators for multiple fuel firing will be discussed with the specific requirements of the paper industry in mind.

Figure 1 shows a simple oil burner. It consists of an air register, a piece of pipe, an atomizer in the end of the pipe, and an impeller. A good oil burner requires ignition plus uniform and thorough mixing of the air and oil. Ignition is aided by the impeller and the air register spins the air to give thorough mixing and turbulence to insure complete combustion in a short time with a minimum of excess air. To convert this simple burner to burn combinations of oil and gas we merely add some gas spuds as shown on Fig. 2. While only one gas spud is shown here, a series of them are placed around the periphery of the burner to get the uniform and thorough mixing we need. If we also want to burn pulverized coal, we add a coal nozzle and change the type of impeller as shown in Fig. 3. Here the impeller is used to disperse the fuel into the air stream. This line diagram looks very simple, but when we put all the elements together to provide a rugged, dependable burner which will do a good burning job with a minimum of maintenance, we get something that looks like this. . . Fig. 4. While it may appear more complex, basically it consists of the simple elements shown earlier.

For low maintenance, you will note the water cooled throat and the alloy tip on the pulverized coal nozzle and the gas spuds. Burners as shown here will burn the fuel with very little excess air. In normal operation we use 7% excess air at the burner for oil and gas to take care of slight maldistribution of fuel and air in multiple burner jobs and to allow some leeway in swinging load. With pulverized coal where it is more difficult to get good distribution of the fuel, we use 15% excess air at the burners.

Furnace requirements for any combination of fuels are set for the worst fuel. Sometimes, the combination of two fuels is worse than when burning either one alone, oil and bark for instance, especially salt water borne bark which may cause troublesome slag or salt deposits. The furnace design requirements are more stringent as the fuels change from a gaseous to a liquid to a solid state. The functions of a furnace are to complete the combustion process, cool the gas and ash particles in order to prevent troublesome slag, and to help collect and dispose of the ash and slag. Size, arrangement, and amount of cooling determine the adequacy of a furnace for a specific fuel or combination of fuels.

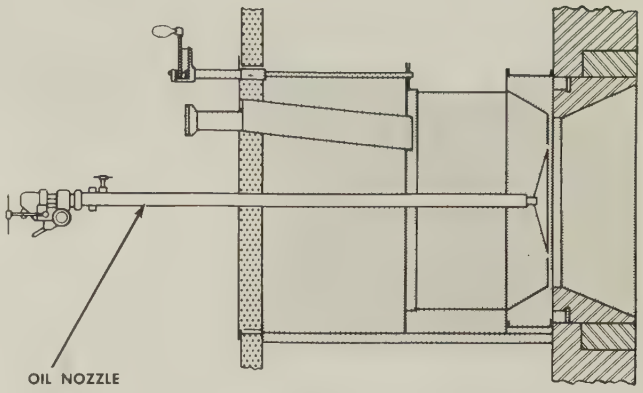

Fig. 1

In the paper industry, bark, or wood, is a fuel that has always been available. In some areas, high moisture has made bark difficult to burn and, consequently, in some cases it is still deemed a nuisance to the extent that it is hauled away and dumped. The refractory dutch oven ranked high in the art of early bark burning days. Because of space requirements and lack of adequate controls, separate boilers were used for burning bark. Thus we were accustomed to bark boilers and power boilers in the typical paper mill. Later, these were combined, as the art progressed. An example of this is shown on Fig. 5. a 120,000 lb. per hr., 860 p.s.i., 825°F. boiler that has been in service a little more than four years in the Northwest. Here we burn bark with 55 to 60% moisture in conjunction with about 10% of the fuel input on oil. Normally, an American Defibrator press is used to reduce the moisture from 70% to about 55 to 60%, but bark has been burned with up to 70% moisture. It should be noted that this high moisture bark is

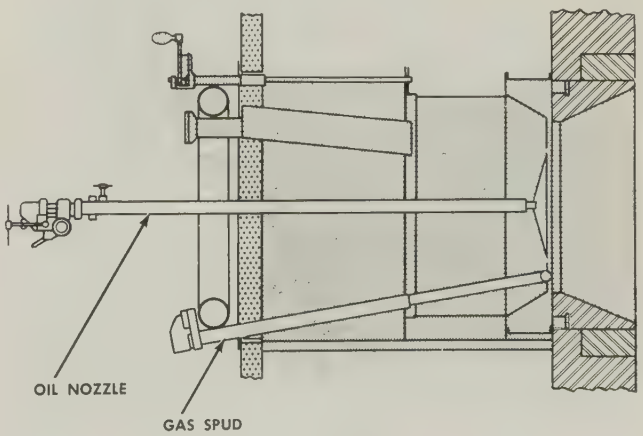

Fig. 2

E. A. KAZMIERSKI, Babcock & Wilcox Co., New York, N. Y.

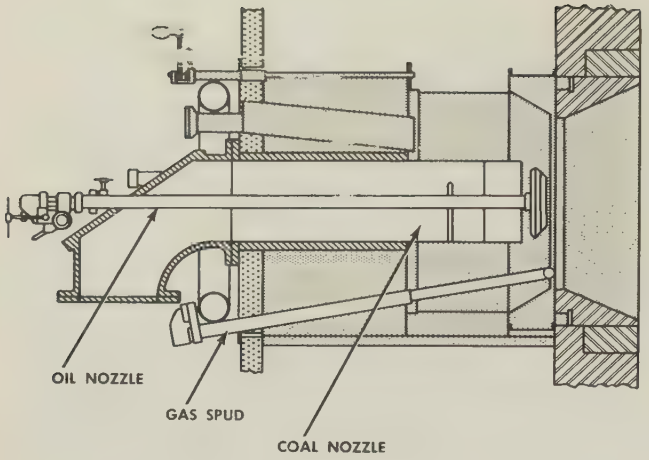

Fig. 3

burned in a completely water cooled furnace. The burning rate on the water cooled grate is about 1,000,000 B.t.u. per sq. ft. per hr. This is aided by the 620°F. air used for combustion. In this particular installation, there is no bark storage and the boiler takes it at the rate that it is produced. Despite the fact that the wood is salt water borne, the long travel retractable soot blowers shown do an effective job of keeping the gas passages clear so that the unit can be kept in service for long periods of time. Ash is allowed to accumulate on the floor and is cleaned by hand once every 3 days.

Figure 6 shows a similar job in the Southeast operating with 45% moisture bark. This unit delivers 200,000 lb. of steam per hr. at 760°F. and 625 p.s.i. While sand is low for this area, because the wood is handled in flumes, there is still appreciable sand and refuse in the bark and it is necessary to clean the floor once per day. You will note that in this installation a mud drum attemperator is used to control the steam temperature over a range in load and also to maintain steam temperature constant with either oil or bark firing.

The same burning method is also used with small capacity units. Figure 7 shows a unit built for 50,000

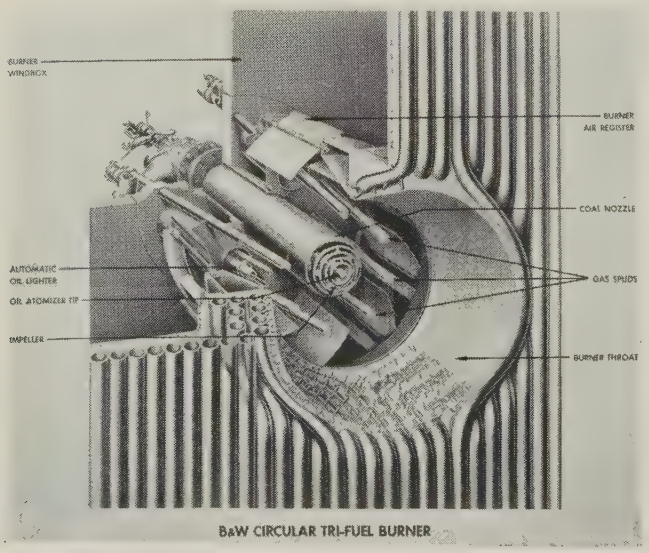

Fig. 4. Pulverized coal, oil, and multispud gas with water-cooled burner throat and automatic oil lighter

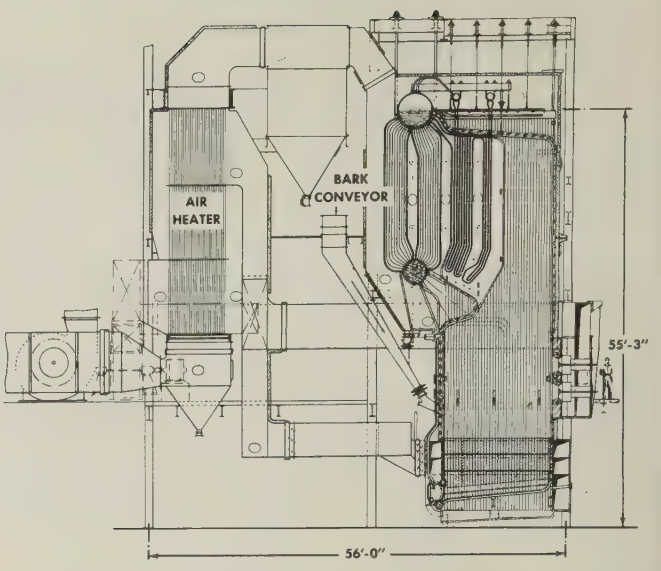

Fig. 5

lb. of saturated steam per hour at 175 p.s.i. It will be noticed that while this boiler has gas baffles, all the others are of the single pass type, which we much prefer. For locations where there is no sand or refuse and where the gas velocities can be held down this unit is practical; whereas in larger units where higher gas velocities are necessary or where sand is prevalent, erosion of the boiler tubes would be experienced.

Where ash or other noncombustibles are high, continuous ash removal may be desirable and in such cases a spreader stoker serves admirably for firing the bark.

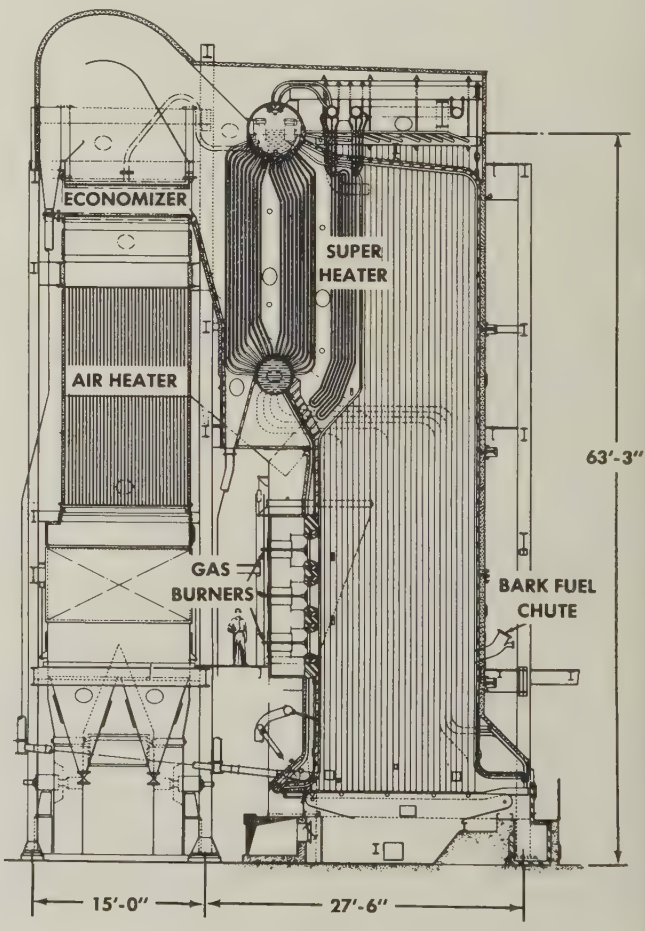

Fig. 6

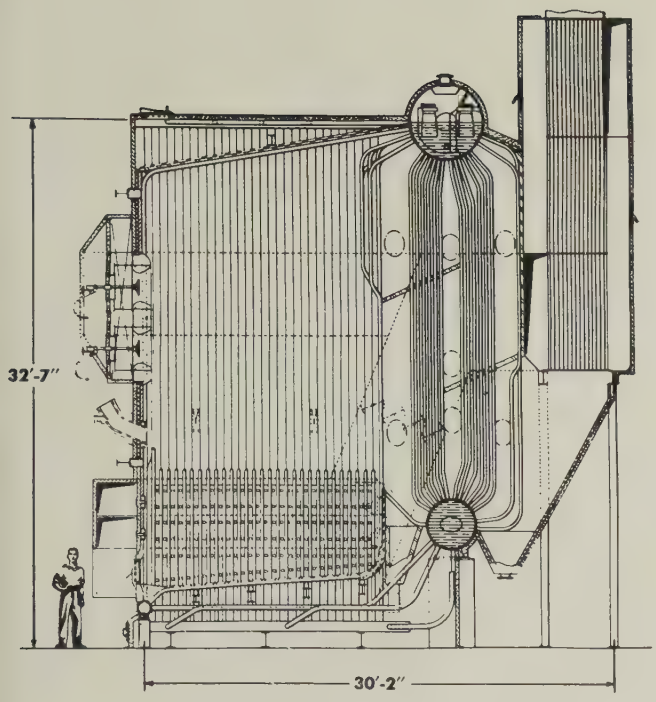

Fig. 7

Figure 8 shows a job rated at 175,000 lb. of steam per hr. at 615 p.s.i. and 750°F. which has been in service about 4 years. Originally, the input on bark was to be about 10% of the fuel input with the remainder on gas, but in actual operation they burn about twice the quantity of bark originally contemplated. This unit

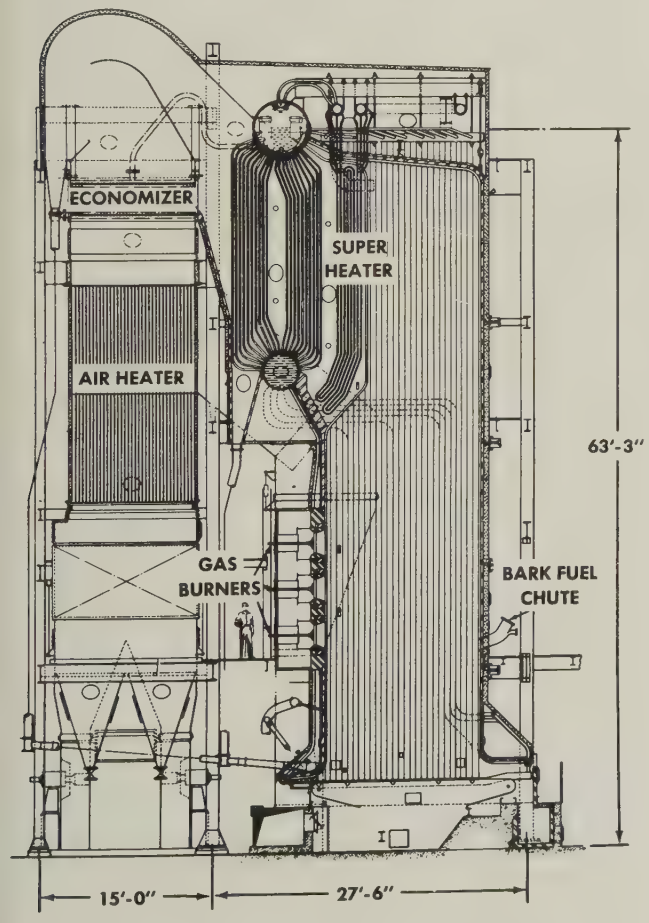

Fig. 8

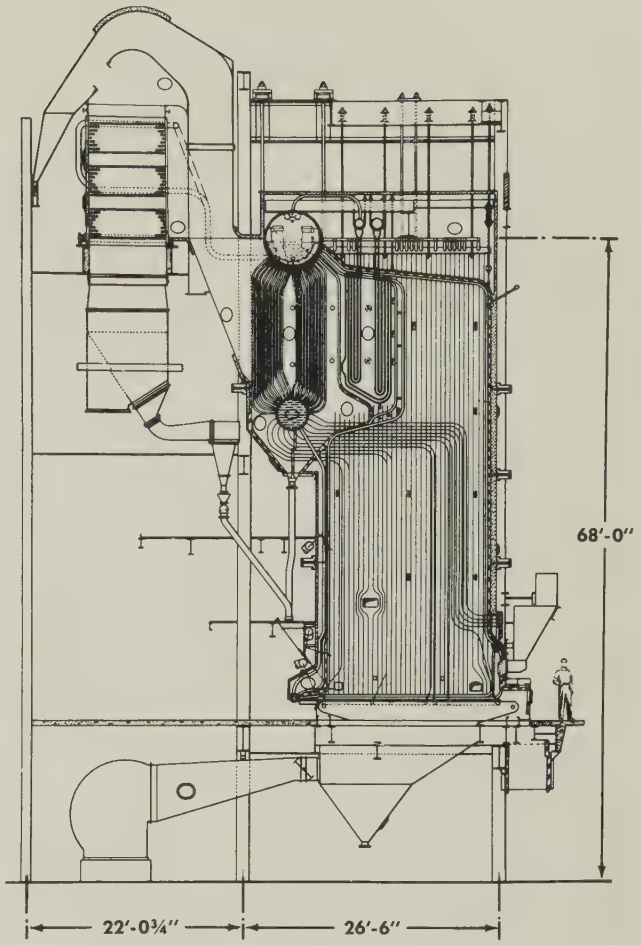

Fig. 9

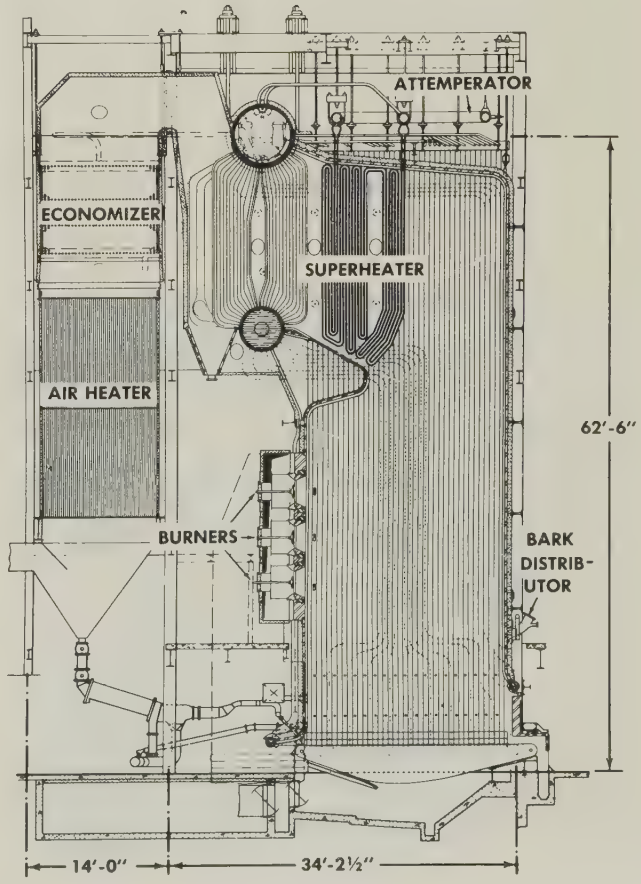

Fig. 10

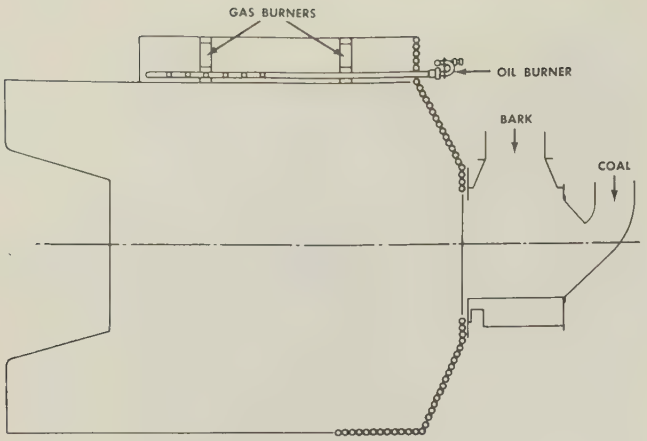

Fig. 11. Burner for cyclone furnace

is equipped with a spray-type attemperator for steam temperature control.

If coal is the alternate fuel with bark we have jobs such as shown on Fig. 9 which is a sectional side view of a boiler designed for 375,000 lb. per hr. at 710°F. and 565 p.s.i. Coal is burned on the spreader stoker and bark is injected in the side walls near the rear. Fuel input on bark ranges up to 25% of the total.

To show the versatility of modern equipment, Fig. 10 shows a boiler built for 300,000 lb. per hr. at 1425 p.s.i. and 725°F. to burn oil and bark. After about $3^1/_2$ year's service, economic conditions changed so that coal was cheaper than oil. A pulverizer was installed and the four lower burners had coal nozzles added so that we now have a coal, oil, and bark boiler.

It will be noted in all of the above illustrations that bark or wood is injected through chutes with air. Distribution is obtained by varying the air flow with continuously rotating dampers. This is simpler and less troublesome than the mechanically driven rotating flippers frequently used. Dust collectors are used in all of the jobs illustrated and the cinders collected are returned to the furnace. In areas where there is appreciable sand, separators are frequently used on the refuse from the dust collectors and only the carbon particles are returned to the furnace.

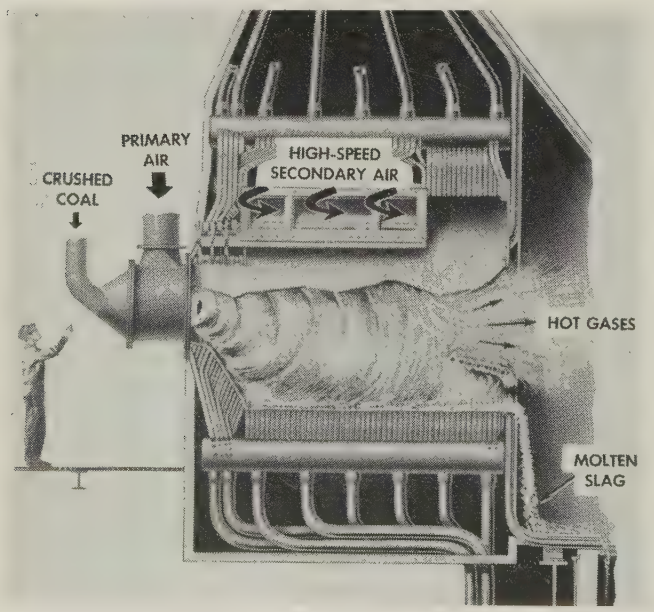

Fig. 12

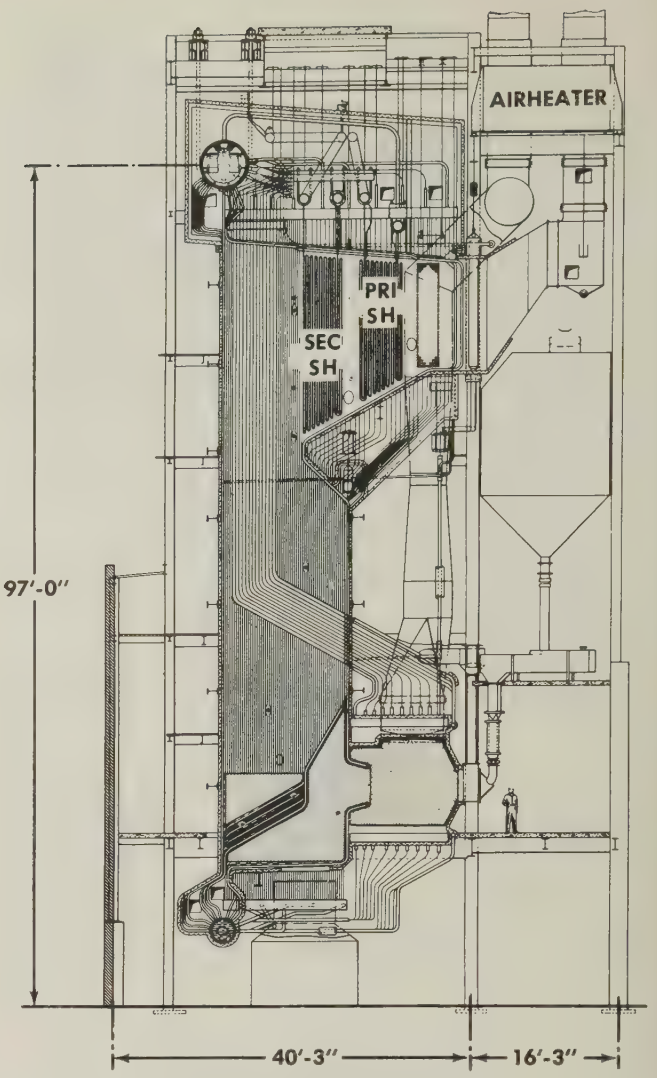

Fig. 13

In areas of the country where barking drums are used and the wood is small, jobs are frequently operated without hogging the bark. In general, if the bark is such that it can be handled on conveyors without hogging, it can be burned in this condition. In the areas where hydraulic barking is used and where the logs are large, it is necessary to hog the bark to handle it more efficiently.

Burning bark in conventional units with combination of fuels poses a number of problems, the most significant of which are:

1. The difficulty of getting satisfactory distribution of bark over the grate or floor.

2. High burning rates result in high cinder carryover. To reduce carbon loss, this must be collected and refired. This brings on a host of problems of its own such as hopper pluggage and fires, difficulty of sand separation when it is necessary, distributing the cinders uniformly over the grate, along with the problem of wear of the cinder return system.

In the beginning, we indicated how an oil burner is converted to a combination oil and gas burner and to an oil, gas, and pulverized coal burner. Now we would like to describe an apparatus originally developed to burn coal and show how simply it can be converted to burn oil, gas or bark. Figure 11 shows a cyclone furnace. Coal is burned completely at very high rates

primarily because the particles are held in a matrix of slag and scrubbed by high velocity air in a region of very high temperatures. Most operators feel that this is the simplest, easiest way of burning coal conceived to date. To burn oil in addition to coal, we add a piece of pipe with some holes in it. To burn gas we add some gas ports. To burn bark we feed it in with the primary air. Coal, oil, or gas can e burned alone or in any proportion. Bark has been burned with any of the other three fuels in proportions up to 50% of the B.t.u. input. Figure 12 is a cut away view showing the arrangement of headers, tubes, and how the cyclone fits into the main furnace.

Due to the difficulty of accurately measuring the B.t.u. input of the bark, it is difficult to properly proportion the air between the grates and the burners in conventional units. This is simple with cyclone furnace firing since all the fuel and air are fed uniformly into the front end together.

Figure 13 shows a cyclone furnace boiler designed to burn gas, coal or bark which has been in service about 2 years. This unit produces 450,000 b. of steam per hour at 1000°F. and 1475 p.s.i. It is probably the highest temperature and pressure unit burning bark in this country today. We are sure you will all agree that this is a far cry from the early refractory dutch ovens for burning bark, so many of which are still in operation today.

Cinder carryover from the cyclone furnace is so little that no effort is made to return it to the furnace. The Ljungstrom air heater shown, has a screen mounted on the underside that rotates with the elements. Any cinders collected on it from the flue gas are removed when it rotates over into the air space.

From the variety of units shown, the following pattern shapes up:

1. For oil or gas firing, in conjunction with bark that has high ash or sand, continuous cleaning of the grates is required, and it is most common to use a spreader stoker type grate in order to reduce manual labor. Where the bark has low ash or sand a much simpler job that is lower in maintenance can be obtained by using a stationary water cooled grate. The lower maintenance is obtained because it is more rugged and is not affected by slag falls, large chunks of wood breaking the grate bars, or by tramp iron binding or breaking a moving grate. Also, the water cooled grate is not subject to damage when burning oil or gas and thus it is not necessary to use cooling air under these circumstances. The cost of hand removal of ash must be considered as partly counter-balancing these savings.

2. If coal is to be an alternate fuel in addition to the bark, we have three possibilities: (a) burn the coal and bark on a spreader stoker, (b) burn the coal in pulverized form and burn the bark on a stoker, (c) use the cyclone furnace for firing all or any combination of fuels.

Each of these have their own limitations. The characteristics of the particular coal affects all three methods, but local conditions are also very pertinent. For low capacities, the spreader stoker for both the coal and bark is adequate and economical.

For higher capacities, and where ash fusion temperature is high enough to reduce the concern over slag falls breaking grates, pulverized coal firing and a spreader stoker for bark firing may look attractive.

Where the total bark to be burned is not over 40% of the fuel input and the coal has an ash fusion temperature of 2400°F., or less, the cyclone furnace has advantages that are very hard to beat.

Presented at the Thirteenth Engineering Conference of the Technical Association of the Pulp and Paper Industry, Portland, Ore., July 28–Aug. 1, 1958.

Elimination of Tracking in Paper Coating Lays

DEXTER L. WOLFE

A process resulting in elimination of coating pattern which is typical in multiple roll coating is described. It was found that the pattern could be virtually eliminated by including in the coating some reactable or hardenable binder, and then, while the coating is still moldable, passing the coated sheet through a nip, the rolls of which have a thin film of hardening solution on the surfaces. A very effective binder combination is carboxymethyl cellulose, starch, and styrene-butadiene latex with the total binder content at from 14 to 20 parts by weight per 100 parts of mineral. The best hardening solution is papermaker's alum. Various coater arrangements for carrying out the process are described.

MACHINE coated paper has gained phenomenal acceptance in the printing field. Its primary advantage is low cost because of the high manufacturing speed. The multiple roll coater is the most common of the types used for on-machine coating. However, multiple roll coaters produce a coating pattern on the paper which is not completely eliminated by the supercalendering operation.

Causes of patterning produced in roll coating are not too well understood. Swanson has reviewed the literature on this phenomenon (*1*). Patterning results from the coating split between the coated surface of the paper and the coater applicator roll. This split of coating takes the form of filaments or threads which, upon breaking, form a ridged or dot pattern on the paper. The type of pattern formed is determined largely by the rheological behavior of the coating, the thickness of film, the base sheet characteristics, and the coater design and speed.

Various methods have been tried to smooth the pattern produced in a roll coater. These include smoothing rolls or rods applied against the freshly coated surface. However, the coating also adheres to these smoothing surfaces, and although the character of the coated surface may be changed, it remains relatively rough. Casting a freshly coated sheet

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against a smooth chrome drier surface will produce a smooth surface, but this process is slow.

DESCRIPTION OF PROCESS

This paper describes a high speed process which results in elimination of the typical coating pattern resulting from roll coating. This is done by including in the coating some rapidly reactable or hardenable

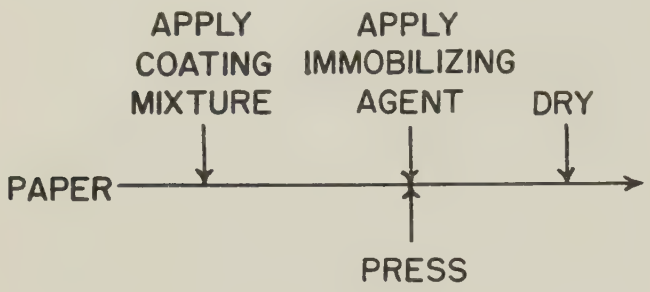

Fig. 1

binder and then passing the coated sheet while the coating is still moldable through a nip, the rolls of which have a thin film of hardening solution on the surfaces. This can be illustrated as shown in Fig. 1.

The simultaneous application of hardening agent and pressure to the moldable coating provides a unique smoothing effect which cannot be obtained if the two operations are carried out individually or in sequence.

Typical reactive binders are proteins, latices, carboxymethyl cellulose, and sodium alginate. They can be used alone or in combination with each other, and with other binders such as starch. CMC is particularly effective since it can be used in relatively small amounts.

The best hardening or immobilizing agent is papermaker's alum. The amount of alum retained by the coated paper is about 0.5 lb. per ream per side (3300 sq. ft.). A sufficient amount of agent is added to the reaction roll to leave a slight film on the roll after the coated sheet is stripped from it. On the other hand, the excess should not be so great as to form a visible bead of solution ahead of the pressure nip. In this case, premature reaction takes place and proper smoothing does not occur.

COATER ARRANGEMENTS

The process was first carried out in the laboratory

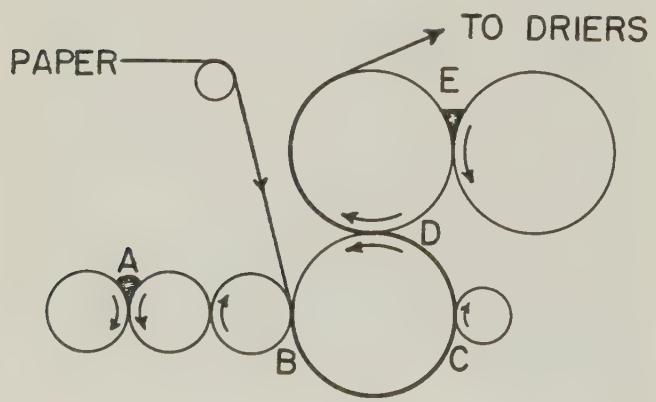

Fig. 2

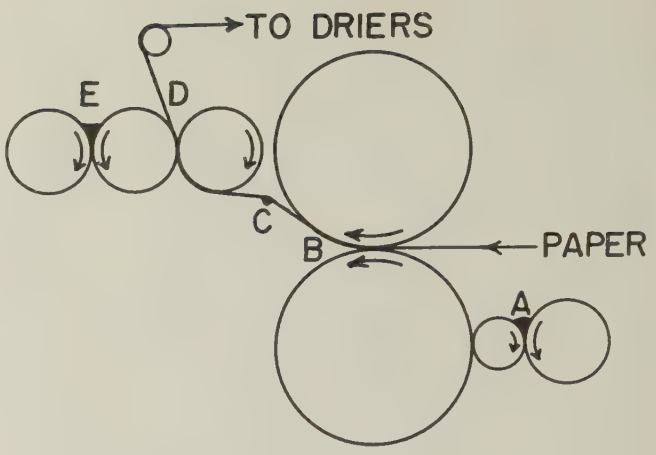

Fig. 3

on a 12-in. wide coater with 6-in. diam. applicator rolls, and 3-in. diam. metering rolls as shown in Fig. 2.

The coating A is metered to the applicator nip B where it is applied to the paper. The coated sheet passes a smoothing roll C, which makes the coating pattern finer. At the reaction nip D, the coated surface is smoothed and hardened by the alum film applied from pond E. The sheet is then dried. This particular coater was operated at 150 f.p.m.

It was soon apparent that the reaction train must be separated from the coating application nip. It was very difficult to keep the reaction solution from leaking down into the coating pond. This set the coating prematurely and prevented its uniform application. Runs made without the smoothing roll were not always successful. The coating pattern was usually so coarsely tracked that although the tracks flattened out in the reaction nip, they did not close up enough to make a smooth surface.

The next step in the development was the use of a 37-in. wide pilot plant coater. The applicator rolls were 25 in. in diam. and the metering rolls 10 in. Among the roll arrangements tried was the one side at a time process shown in Fig. 3.

The rolls at the right make up a conventional one side multiple roll coater with coating being metered from pond A and applied at nip B. The sheet then passes over a $^1/_4$-in. diam. reverse turning rod C to remove the sharp pattern tracks. This smoothing has very little effect on the printing smoothness, and may not be necessary in all cases. The reaction press at the left consists of a hard rubber metering roll for reaction solution E, a chromium-plated reaction roll in the middle, and a hard rubber backing roll. The reaction nip is shown at D.

This one side coater was operated at up to 500 f.p.m. Excellent results were obtained in terms of coated

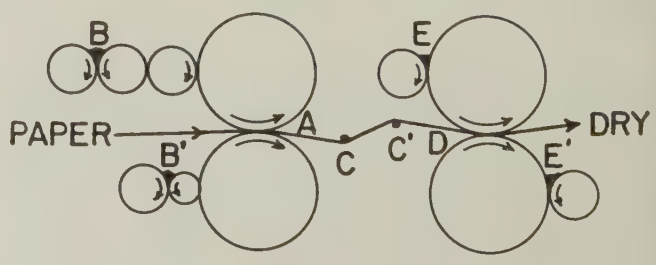

Fig. 4

surface smoothness. However, in order to simplify the coater arrangement, a two side at a time coater was built as shown in Fig. 4.

Coating is applied to both sides of the sheet at once at nip A. Coating is fed to the applicator rolls from ponds B and B[1]. The coated sheet then passes over 1/4-in. diam. revolving smoothing rods C and C[1]. Reaction nip D is formed by 25-in. diam. hard rubber rolls (25 to 35 plastometer). Immobilizing solution is fed from ponds E and E[1] with chromium-plated metering rolls. The smoothing effect of the hard rubber rolls is not quite as good as with the chromium roll in the one side process. One metal roll could be used, but a two-sided effect is produced. And since two metal rolls cannot be used on a wet sheet, the most satisfactory compromise is to use two hard rubber rolls. Best results are obtained with fairly high pressures in this reaction nip (approximately 80 to 100 lb. per linear in.). The coating film entering the reaction nip is hardened or set by the reaction solution and smoothed at the same time by pressure in nip D. Coating on the paper at this point must be readily moldable. For this reason, coating application nip A and reaction nip D should be as close together as possible. A time interval of less than 0.5 sec. is desirable between these nips. In this particular arrangement these nips were 4 ft. apart.

This pilot plant two side coater was operated at speeds up to 900 f.p.m. with no indication of speed limitations as far as the process is concerned. Another advantage to this process is the absence of coating pick on the succeeding driers. The coated surface leaving the reaction nip is set or hardened so that it cannot readily be disturbed.

COATING FORMULATIONS

Coatings used in this process have been made up to 65% solids with the normal range of from 50 to 60%. Viscosities are run a little lower than usual for roll coaters (3000–5000 cp.—Brookfield no. 6 spindle 100 r.p.m.). Coatings with viscosities in this range level better in the reaction nip.

Most effective coating formulations have included CMC which reacts very rapidly with alum solutions. A typical formulation is 1.5% CMC (0.75 degree of substitution—Hercules grade 70 low or medium viscosity), 10% commercially or enzyme modified starch, 3.5% styrene-butadiene latex (Dow 512-K), 15 $CaCO_3$, 70% clay. Latex gives a softer, more plastic film which improves print results. Calcium carbonate has the desirable benefit of increased brightness because of the calcium carbonate-alum reaction. The CMC can be added dry to the coating dough-type kneaders with the minerals and dispersing agents and kneaded at high solids. The CMC is dissolved by the end of the normal cycle of about one-half hour. Then the cooked starch is added, followed by the protein-stabilized latex. More details on coating formulations used in this process are described in U. S. pat. 2,772,-184 (*2*).

Coat weights applied have varied from 6 lb. to close to 30 lb. total two sides. Lightweight coats (6 to 9 lb.) have not proved too successful in terms of printing improvement. Too little coating is available to level out the surface. Likewise, the heavy-weight single coats are not always successful. Some poor sheet stability has resulted with these heavier coat weights. In addition, if conditions are not adjusted carefully in the reaction nip, the hardened film of coating may rupture and roughen in the reaction nip. For heavy coat weights the best paper was produced by applying 12 to 15 lb. of reaction coat over a conventional roll coated base coat of 12 to 15 lb.

Alum solution used with CMC containing coatings was made up at 1.17 to 1.21 sp. gr. (4 to 5 lb. alum in 10 lb. water). Iron-free alum gives a clearer solution than regular papermaker's alum, and was used for the higher grade sheets. The alum was circulated from the nip and normally would have to be clarified before reuse. Fine particles of coating or mineral slowly build up in the solution. This material can be removed readily by settling. Measurements have shown that about one quarter of the alum film metered onto the reaction rolls is transferred to the paper.

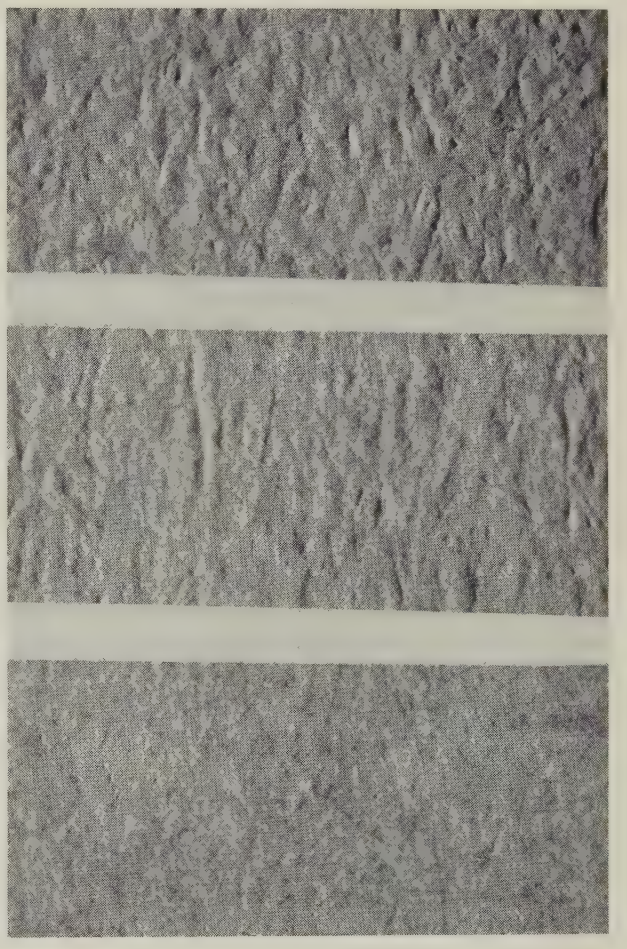

Fig. 5

The smooth coated surface produced by this process results in easier supering paper than comparable normal coated grades. This means better bulk, brightness and opacity. Dull finished paper with better printability characteristics than presently available commercial grades has been produced. Supering conditions have to be changed for dull coats, however, since normal supercalender stacks with alternating fiber and steel rolls are apt to produce surface mottle. Best results were obtained with fiber to fiber roll nips.

SURFACE CHARACTERISTICS

The photomicrographs shown in Fig. 5 illustrate the variations in surface roughness obtained through the process. These pictures of unsupercalendered paper were taken with an angle of illumination of less than 10 degrees, and are magnified 14 times. The top picture shows a typical multiple roll coater pattern. The middle picture shows what the smoothing rod does to this surface. The pattern is still relatively rough, but the sharp peaks and valleys are smoothed out somewhat. The lower picture shows this same coated surface after the coated sheet passes through the reaction nip. The smoothing obtained in this nip is readily apparent.

Various types of paper produced by this process have been printed in commercial shops by the letterpress, rotogravure, and offset printing processes. The improved printing surface compared to normal roll coated grades has been demonstrated by these field trials, as well as by intensive laboratory analysis.

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2. Wolfe, D. L., and Hoel, L. W., U. S. pat. 2,772,184 (Nov. 27, 1956).

Presented at the Ninth Coating Conference of the Technical Association of the Pulp and Paper Industry, Bedford, Pa., May 14–16, 1958.

Some Experiments on the Water-Cellulose Fiber System

J. A. VAN DEN AKKER, W. A. WINK, and F. C. BOBB

This paper presents the results of studies of the moisture content of never-dried pulp (a) after intensive compressive stressing, and (b) in the free, uncompressed state, at equilibrium under various controlled relative vapor pressures, with special reference to relative vapor pressures approaching unity. Experimental work with two piezometers of special design showed that (1) the approach of the moisture content to an equilibrium value is very slow, presumably because of a "gasket effect" resulting from the high compressive stress; (2) equilibrium under high compressive stress is eventually reached, at which the hydrostatic pressure of the water throughout the compressed fiber button is at atmospheric pressure, thus permitting estimation of the density of the volume of cellulose not available to water; (3) this density is slightly higher than that of crystalline cellulose, probably because the specific volume of the most energetically sorbed water is less than that of free water; (4) the moisture content (dry basis) of the fiber button under high compressive stress (including the interstitial water) approached an equilibrium value of only 19.6% under a compressive stress of 7450 p.s.i., showing that the wet fiber wall is pliable and "spongy" with respect to ingress and egress of water under mechanical action (it is estimated that water may be expressed from pores of size ranging down to at least 60 A.). The question as to whether or not there is a "fiber saturation point" for a chemical pulp is considered with the help of information on equilibrium values of moisture content obtained at relative vapor pressures approaching unity. This information (together with theoretical considerations) leads to the conclusion that there is not a "fiber saturation point" for a chemical wood pulp; accordingly, it is suggested that the concept of "fiber saturation point," at least as it relates to chemical pulps, be abandoned as useless and misleading.

Two of the properties of pulp fibers which are of theoretical importance to the behavior and performance of a pulp are fiber flexibility and fiber swelling. Without doubt these factors are intimately related for, without inhibition of water and the consequent swelling, the fiber would not become flexible on being brought into contact with water. The swelling and enhanced flexibility and pliability of papermaking fibers which result from wetting with water are related to the promotion of fiber-to-fiber bonding by wet pressing and surface tension through the Campbell effect (*1*) when the paper web dries. Thus, it is of real interest to evaluate the wet flexibility and swelling of pulp fibers. This article presents a brief account of work done at The Institute of Paper Chemistry in connection with the pulp evaluation program on water-cellulose relationships.*

Past studies in this interesting area have been discussed extensively by Stamm (*2*) and Clark (*3*). Over a period of years, Jayme has evolved a centrifugal method for determining the water associated with pulp fibers, and his method has been developed to the point of stimulating wide interest (*4*).

Two questions gave rise to the work described in this article. The first related to the effect of pressure on the distribution of water in a pulp fiber-water system and the second had to do with the utility of the "fiber saturation point" in estimating the amount of water associated with the fiber wall. Specially designed piezometers were designed for the study of compressed fiber-water systems, while information relating to "fiber saturation point" was obtained through determination of the moisture sorption isotherm.

OBSERVATIONS WITH PIEZOMETERS

Each of the two piezometers constructed for this work was designed to compress a cylindrical mass of pulp fiber and water under known stress, in such manner that the volume of the fiber-water system could be accurately measured. The first apparatus, designed to be loaded in an Amsler testing machine, is shown in Fig. 1. The components of the piezometer are shown in Fig. 2; these are the ram *a*, the nonporous and porous sleeves *b* and *d* (which served the purpose of containing the specimen from radial expansion), and the lower boss *c*. The ram and lower boss were suitably linked to a dial micrometer for the accurate determination of the distance between the compressing surfaces. The nature of the linkage with the micrometer, shown in

J. A. Van den Akker, Senior Research Associate, W. A. Wink, Research Associate, and F. C. Bobb, Research Aide (present address Research & Engineering Div., Continental Can Co., Chicago, Ill.), The Institute of Paper Chemistry, Appleton, Wis. Work done at The Institute of Paper Chemistry.

* The material in this paper has been condensed from reports submitted to the "Pulp Evaluation Group."

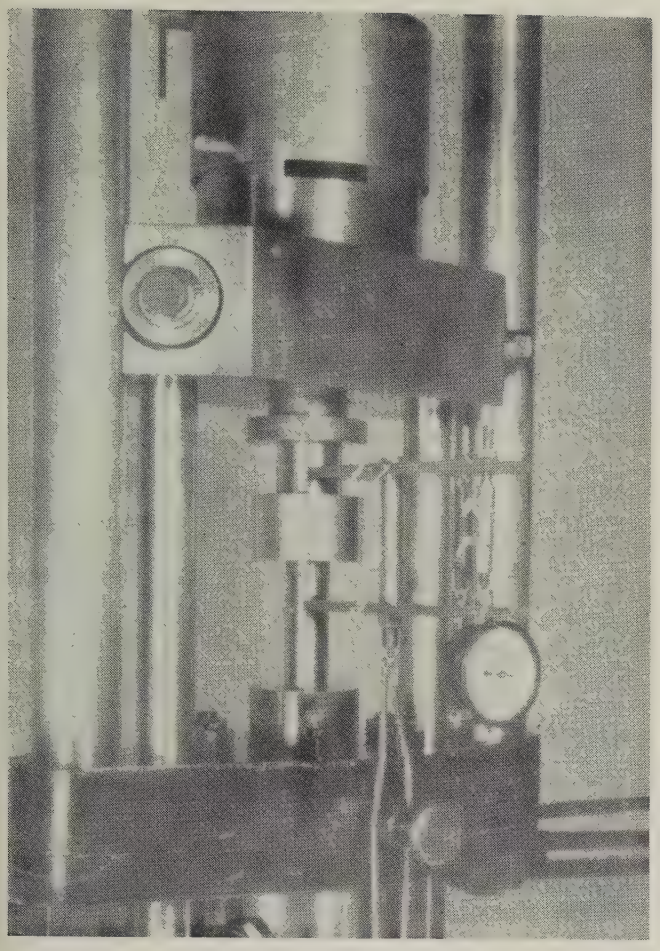

Fig. 1. The first piezometer, mounted in an Amsler Universal Testing Machine

Fig. 1, was such that accurate compression of pulp fibers contained in the piezometer could not be obtained directly from the micrometer dial reading, but were determined by elementary calculation. In the first work, a porous bronze sleeve, reinforced by a massive block of steel, was employed so that expressed water could move from the system without undue resistance. The earliest runs demonstrated, however, that the rate of expression of water was limited by the resistance to flow within the fiber-water system itself, so that the long-term runs could be conducted satisfactorily with sleeves fabricated from nonporous metal. In order that the packing of the piezometer might be done with maximum effectiveness, the combination of lower boss

Fig. 2. The ram (a) and boss (c) and nonporous (b) and porous (d) sleeves used in the piezometer illustrated in Fig. 1, where parts, a, b, and c were employed

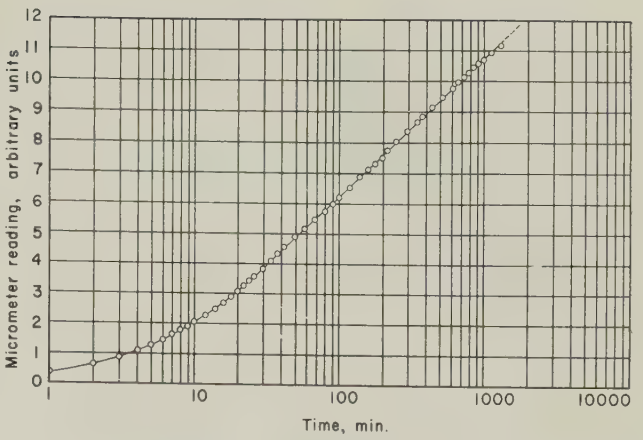

Fig. 3. Ram displacement (uncorrected) on a wet fiber button as a function of time, for a sustained compressive stress of 18,400 p.s.i.

and sleeve was packed with a button of disks of wet fibers which had been punched from a pile of wet British handsheets. In using this and the piezometer later designed, only a few thicknesses of wet handsheets were punched simultaneously to obtain well-defined, clean-cut edges; approximately 20 disks, five sheets each, were used to form each button.

Illustrative data obtained with the first piezometer are presented in Fig. 3, in which the compression is plotted against the logarithm of time of duration of a ram loading of 15,000 lb., corresponding to a stress on the wet fiber button of 18,400 p.s.i.* The moisture content of the fiber button at the end of the run was only 27.8% (oven-dry basis) and the over-all density of the water-fiber system in the piezometer, under load, was 1.51 g. per cc. The pulp was a spruce sulphite, prepared by the Mitscherlich process. The formation and couching of the British sheets were carried out in accordance with standard procedures, except that the method of pressing the sheets was modified to augment the water content of the sheets: After couching, each sheet was placed between the couching blotter and another blotter, and groups of five sheets were pressed simultaneously for a period of 15 sec. at a pressure of 5 p.s.i.

On referring to Fig. 3, it will be seen that the plot of the ram displacement against the logarithm of the time is a curve with increasing slope during the first several hours. Without doubt, this result was only partly ascribable to creep; it seems probable that the fluid permeability of the fiber button was very low as a result of the diminution of pore size under the compressive stress of 18,400 p.s.i.—undoubtedly, this accounts for the slow expression of water. Even after 1400 min., the curve displayed no tendency to level out to an equilibrium value. After several experimental runs, using porous and nonporous sleeves around the fiber button, it was judged that the data would not be useful, primarily because the *hydrostatic* pressure of the water in the fiber-water system varied throughout the button from atmospheric pressure to some unknown high value.

Accordingly, attention was directed to the develop-

* The particular data presented in Fig. 3 were obtained using the Baldwin-Southwark testing machine, with the automatic load-maintainer; all other data obtained in the preliminary study with the first piezometer were observed with the Amsler testing machine.

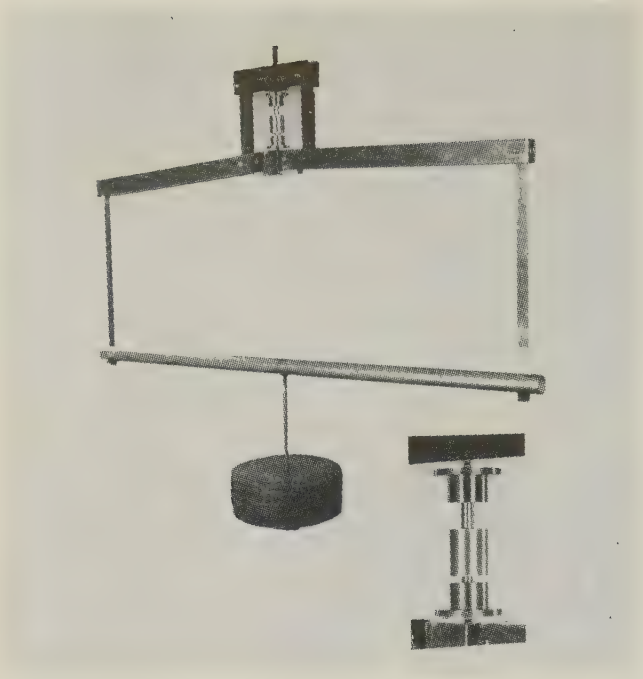

Fig. 4

(*a*) Arrangement of levers and "dead-weight loading" for maintaining the second piezometer under a constant load. (*b*) Close-up view of the second piezometer.

ment of an apparatus which would permit long-term runs resulting in equilibrium of the system and, in consequence, yield the condition in which the water in the fiber button should everywhere be at one atmosphere, while the button is under very high compressive stress. In order that long-term, constant compressive stressing could be applied to the wet fiber button (and also to release the testing equipment for other purposes), the apparatus shown in Fig. 4a was developed. Utilizing the principle of dead weight-loading, this equipment was capable of maintaining compressive stresses greater than 7,000 p.s.i. for a ram diameter of 0.500 in. Load was applied to a very carefully constructed piezometer by way of steel balls, as shown in Fig. 4b. The end flanges of the piezometer permitted the operator to apply a calibrated micrometer to the inner faces of the flanges, and thereby arrive at an accurate calculation of the fiber button thickness.

In the first run with the new apparatus, the wet pulp button was prepared from the Mitscherlich sulphite pulp. The unbeaten pulp, which had never been dried, was made into handsheets with the British sheet mold and wet pressed between blotters for 15 sec. at 5 p.s.i. In order that a saturated atmosphere of water vapor would be maintained around the pulp throughout the duration of a run, a seamless polyethylene sleeve, sealed to the cylindrical bodies of the ram and boss, prevented escape of water vapor. (During the runs, droplets of water formed on the inner surface of the sleeve, and there was no doubt that drying was completely inhibited.) After the load was applied, the distance between the flanges of the ram and boss bases was measured at three equally spaced points around the piezometer, using the calibrated dial micrometer to which reference has already been made. The measuring system was calibrated by substituting steel plugs of exactly known thickness for the pulp button; the data were obtained with the equipment under load, so that calibration would include deformation effects.

When the volume of the wet fiber button reached equilibrium, the polyethylene sleeve was removed and all water that had accumulated around the cylinder was carefully removed with blotters. The load was then released, and the fiber button quickly placed in a tared bottle, weighed, and dried at 105°C. to determine the water content and the oven-dry fiber weight.

The results of the first successful run with the new equipment are presented in Fig. 5, in which the volume of the compressed fiber-water system is plotted against time on a logarithmic scale. The compressive stress in this run was maintained constant at 7450 p.s.i. for a period of 481 hr. It is apparent that equilibrium was established in about 250 hr., but the run was prolonged to prove that equilibrium had been established; during the last 100 hr. of the run, the thickness of the button varied less than 0.0001 in.

It is of considerable interest to note that the moisture content of the fiber button at the conclusion of the run shown in Fig. 5 was only 19.6% on the oven-dry basis and, of course, this includes the interstitial water. It is clear that water was mechanically expressed from the fiber wall. In a study of the moisture retention of pulps as a function of beating, Sedoff, Holmberg, and Jahn (*5*) obtained low moisture contents through the use of high compressive stress; their experimental runs were of short duration, and the hydrostatic pressure of the water varied, as in our preliminary experiments, throughout the compressed fiber-water system.

It seems probable that any small amount of air initially present in the fiber-water system is removed during the first few hours of loading. Subsequently, under the action of the high pressure, the residual air is either compressed to a negligible volume, or dissolved in the water. As water is expressed from the fiber button, it carries air with it, either in dissolved form, or mechanically in the form of minute bubbles which may form when the water reaches the outer surface of the fiber button, where the hydrostatic pressure is low. Finally, at equilibrium, after most of the water has been removed, and the hydrostatic pressure in the water is substantially atmospheric, it is conceivable that a small volume of air (gas phase) is released because of the lowered hydrostatic pressure of the water. In our

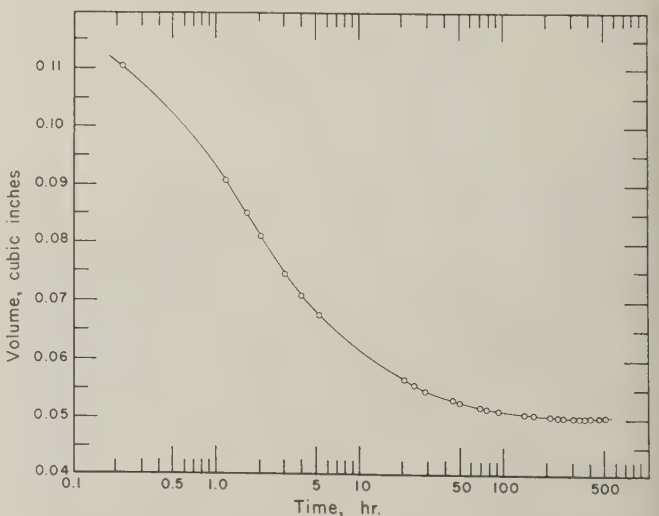

Fig. 5. Volume of a wet fiber button (in the second piezometer) as a function of time (log scale)

Table I. Mass and Volume Data for Fiber Buttons at Equilibrium, Under Compressive Stress

Constant compressive stress applied, p.s.i.	*Time the compressive stress was applied, days*	*Equilibrium volume V, cc.*	*Oven-dry weight of fiber M, g.*	*Weight of water in button at equilibrium W, g.*	*W/M, %*	*Density g./cc. M/(V − eW)*
1525	214	1.0750	1.0520	0.4295	40.8	1.63
4800	26	0.8980	1.0360	0.2487	24.0	1.60
7450	20	0.8185	0.9996	0.1957	19.6	1.61

opinion, the total volume of air in bubble form is small at the conclusion of a run to equilibrium.

After the compressive stress has been maintained for a time sufficient for equilibrium to be reached, the following equation holds:

$$v - ew_f = (V - eW)/M \qquad (1)$$

v = specific volume of solid substance of the fiber.
e = specific volume of water (at atmospheric pressure).
w_f = water content of the fiber wall (dry basis).
V = total volume of the compressed system.
W = total weight of water in the system.
M = oven-dry weight of fiber in the system.

Since the equation applies to the fiber-water system at equilibrium and the hydrostatic pressure of the water is essentially atmospheric throughout the system, the specific volume of the water, e, is for room temperature and atmospheric pressure. In the derivation of equation (1) it was assumed that the total volume of gaseous air in the system is negligible, and in the utilization of the equation the specific volume of the water contained in the system was taken to be that of air-free water, viz., about 1.002 cc. per g.

Three runs to equilibrium were made at compressive stresses of 1525, 4800, and 7450 p.s.i. The essential data obtained in these runs are presented in Table I.

The time required to obtain equilibrium, several days less than the period given in the second column of Table I, was substantial in all three cases. The extraordinarily long time required for a definite leveling of the volume-log (time) curve for the run conducted at the lowest compressive stress is unexplained.

It will be seen that the moisture content (dry basis) is very low for the higher compressive stress. If the calculations of Barkas (*6*) relating to capillary condensation of water in pulp are correct, water was mechanically expressed from pores of size down to at least 60 A. (this estimation calls into play both the calculations of Barkas and the desorption isotherm for the pulp, for which see Fig. 7). Since we are here concerned with appreciable deformation of the fiber structure, this result implies that the rigidity of a wet pulp fiber is of a low order of magnitude and that the body of a water-saturated fiber is "spongy" and porous with respect to ingress and egress of water under the action of mechanical forces.

As indicated earlier, the long times required for the attainment of equilibrium in these experiments is undoubtedly attributable to the greatly enhanced resistance in a fiber button to fluid flow as a result of the high compressive stress; indeed, the compressed fiber button becomes a gasket, and one may speak of the slow expression of water during the last days of a run as the "gasket effect." If it were feasible to make accurate experimental observations on an assemblage of only several fibers, the expectation would be that the mechanical expression of water from the individual fibers should occur in a very short period of time (possibly a small fraction of a second for several fibers as contrasted with many days for a fiber button containing several millions of fibers).

Of some interest are the data on density given in the last column of Table I. These relate to the volume of the cellulose system not available to water. It will be seen that the numerical values are somewhat higher than the calculated density of crystalline cellulose (*7*). It might be presumed that the density was augmented by the compressive stress, although it should be noticed that a nearly fivefold increase in compressive stress produced, if anything, a slight reduction in density; in this connection, it should be remembered that the hydrostatic pressure of the water in the system was essentially 1 atm., and it should further be noted that the relative change in volume of a fibrous material under compressive loading would not be expected to be the same as that of the same material under fluid pressure of the same numerical value. It is probable that the densities presented in Table I would be reduced somewhat if allowance were made for the fact that the specific volume of the most energetically-bound water contained in wet fiber is substantially less than 1.0 (*8*); in other words, eW appearing in the denominator of $M/(V - eW)$ is actually less than the value employed, and a lessening of the value would, of course, decrease the calculated density.

IS THERE A "FIBER SATURATION POINT" FOR A CHEMICAL PULP?

Reference has already been made to the desorption isotherm for the Mitscherlich sulphite pulp employed in the present study (Fig. 7). Another reason, ini-

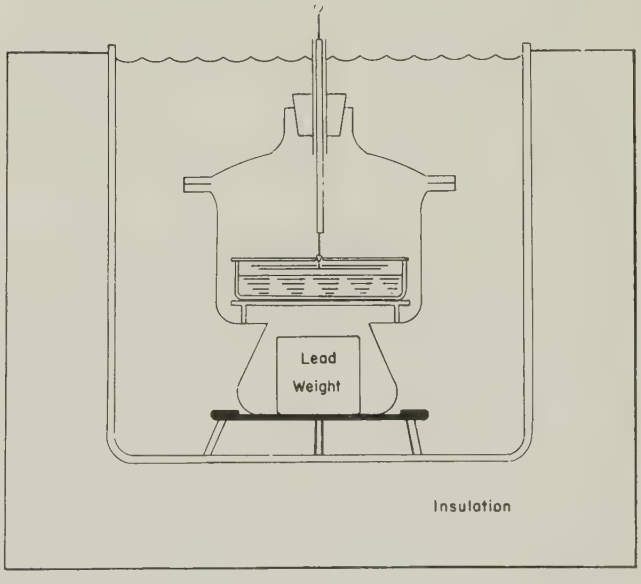

Fig. 6. Schematic diagram of the Wink apparatus for determination of the desorption isotherm shown in Fig. 7

tially, for determining the desorption isotherm was the hope that the sorption data, obtained at high relative vapor pressure, would permit at least an approximate determination of "fiber saturation point" which would be of value in characterizing a pulp. For years, such determinations have been done by means of an extrapolative technique (*2*).

It is well known that sorption data at relative vapor pressures approaching 1.0 are reliable only when the technique is appropriate, and the temperature is held within extremely small limits. In the present work, desorption data were obtained by application of the Wink method (*9*); a schematic diagram of the apparatus is shown in Fig. 6. Accurate determinations of the relative vapor pressure over three saturated salt solutions yielding high relative vapor pressure were obtained by means of apparatus developed by Wink and Sears (*10*).

The vapor pressures obtained for three of the saturated salt solutions are given in the following tabulation:

Saturated salt solution (22.85°C.)	*Relative humidity %*
NaF	96.97 ± 0.02
K_2SO_4	97.83 ± 0.02
Li_2CO_3	99.39 ± 0.02

The Wink apparatus, containing one of these salt solutions, was placed in a constant temperature bath controlled at 22.85°C. by means of a selected mercury-to-platinum thermoregulator, which held the bath temperature sufficiently steady that no fluctuation could be detected on a Beckmann thermometer (that is, the fluctuations were less than about 0.001°C.). The saturated salt solution was contained in a crystallizing dish, an excess of the salt having been used, so that areas of wet salt stood above the general liquid level. The pulp specimen was in the form of two pulp sheets, each 4 in. in diameter, and these were supported immediately above the surface of the saturated salt solution (with a spacing of about 1/4 in.) by means of a 3/4-in. square mesh brass screen.

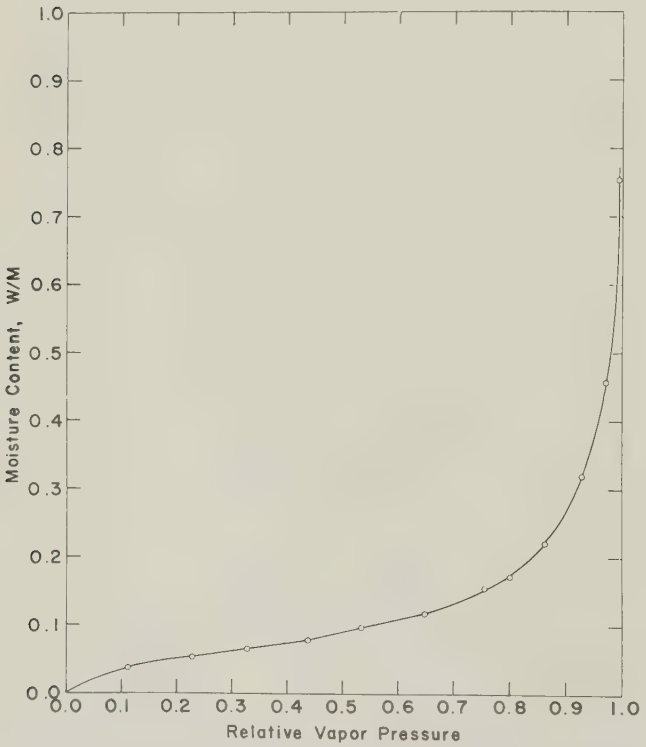

Fig. 7. Desorption isotherm of the Mitscherlich sulphite pulp

The first successful run made with the equipment at high relative vapor pressure (99.39%) was conducted (as were subsequent runs) with a pulp specimen which had never dried, so that it came to equilibrium by desorption. Equilibrium was apparently reached in a few hundred hours, and the run was terminated at 768 hr. During the last 150 hr., the fluctuations in weight were less than 1 mg. The equilibrium moisture content of the specimen was 75.4% on the oven-dry basis. Further data obtained at high and ordinary relative vapor pressures are plotted in Fig. 7. This desorption isotherm does not justify the prevalent idea that such curves can be extrapolated at high relative vapor pressures to 1.0 to obtain a "fiber saturation point." In a very careful series of determinations of the moisture sorption isotherms of textile fibers, with particular reference to relative vapor pressures approaching unity, Ashpole (*11*) has shown that there is not a unique saturation value (obtainable by extrapolation) for such fibers; the present work shows that this finding applies to a chemical wood pulp, and the desorption isotherm shown in Fig. 7 plainly demonstrates the futility of the concept of "fiber saturation point," at least as this concept relates to such a pulp. It is clear that a "fiber saturation point" cannot be experimentally determined for a chemical wood pulp and, since this can be explained on theoretical grounds,* it is suggested that the concept of "fiber saturation point," at least in connection with chemical pulps, be abandoned as useless and misleading.

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* Capillary condensation in voids having a wide distribution in size, varying from the submicroscopic pores of the fiber wall to the coarse interstitial voids of a pulp mass, should result in an isotherm which would approach relative vapor pressure of 1.0 with ever-increasing slope to a high moisture content, the exact *equilibrium* value depending upon the state of compaction of the pulp; indeed, if the pulp container were hydrophilic, the limiting moisture content would become the mass of water held in the filled container divided by the dry weight of the fiber—this could be made to approach any value.

Received Nov. 24, 1958.

ASSOCIATION NEWS AND EVENTS

National Conferences

Tenth Coating Conference, Statler Hotel, Boston, Mass., May 25–27, 1959.

Tenth Testing Conference, Multnomah Hotel, Portland, Ore., Aug. 17–21, 1959.

Fundamental Research-Wet Strength Conference, I.P.C., Appleton, Wis., Sept. 9–11, 1959.

Ninth Corrugated Containers Conference, Jung Hotel, New Orleans, La., Sept. 15–17, 1959.

Fourteenth Paper-Plastics Conference, Edgewater Beach Hotel, Chicago, Ill., Sept. 21-23, 1959.

Fourteenth Engineering Conference, Penn-Sheraton Hotel, Pittsburgh, Pa., Oct. 12–15, 1959.

Thirteenth Alkaline Pulping Conference, Robert Meyer Hotel, Jacksonville, Fla., Nov. 4–6, 1959.

Local Section Meetings

Pacific: Gearhart, Ore., May 21–23, 1959, "Multiple Water Use." Joint TAPPI-Superintendents annual meeting.

Golden Gate District (Pacific Section): May 5, 1959.

Kalamazoo Valley: Hotel Harris, Kalamazoo, Mich., May 14, 1959, Recognition Night for Western Michigan University award winners.

Chicago (Chicago Bar Association, 29 So. LaSalle St., Chicago, Ill.): May 5, 1959.

St. Louis District (Chicago Section) Le Chateau Restaurant, 10405 Clayton Road, St. Louis (all meetings).

Maine-New Hampshire: Samoset Hotel, Rockland, Me., June 12–13, 1959.

New England: June, 1959. Place and date to be determined.

Eastern District (New England Section): June 1959, annual meeting with New England Section.

Southeastern: Jekyll Island Hotel, Jekyll Island, Ga. May 8, 1959.

Gulf Coast District (Southeastern Section): New Orleans, La., May 15, 1959.

Virginia-Carolina: Franklin, Va., May 15, 1959. Visit to mill of Union Bag-Camp Paper Corp.

Lake Erie:

Papermakers and Associates of Southern California: Los Angeles, Calif., May 21, 1959.

Lake States: Menasha, Wis., May 12, 1959, C. J. West Award Meeting.

Delaware Valley (all meetings held at Engineers Club, Philadelphia, Pa.): May 22, 1959.

Ohio: Hartwell Recreation Center, Cincinnati, Ohio, May 14, 1950, Annual Meeting.

Indiana District (Ohio Section) (meetings at the Hunt Room, Marott Hotel, Indianapolis, Ind.): May 19, 1959; and June 16, 1959.

Empire State: Whiteface Inn, Whiteface, N. Y., June 11–14, 1959. Annual meeting.

Empire State (Central District) (all meetings to be held at the University Club, 431 East Fayette St., Syracuse, N. Y.): May 1, 1959, "Senior Night," NYSCF; May 21, 1959, annual meeting of Fulton C. of C., Fulton, N. Y.

Empire State (Metropolitan District) (all meetings to be held at 465 Lexington Ave., New York, N. Y.): May 12, 1959; Annual Meeting.

Empire State (Northern District) (all meetings to be held at Woodruff Hotel, Watertown, N. Y.): Annual Meeting, May 14, 1959.

Empire State (Eastern District) (all meetings to be held at Queensbury Hotel, Glens Falls, N. Y.): Annual Symposium, subject to be announced, May 21, 1959.

Empire State (Western District) (all meetings at the Prospect House, Niagara Falls, N. Y., unless otherwise indicated): May (Details to be announced later).

Other 1959 Conferences

June 17–20	CPPA Summer Meeting, Manor Richelieu Hotel, Murray Bay, P. Q.
Sept. 13–18	Am. Chem. Society, Atlantic City, N. J.
Oct. 26–28	Packaging Institute, Statler Hotel, New York, N. Y.
Nov. 9–11	National Paperboard Assoc., New York, N. Y.

Empire State (Eastern District)

The Annual Symposium of the Eastern District of the Empire State Section of TAPPI will be held on May 21, 1959 at the Queensbury Hotel in Glens Falls, New York. The subject this year is to be on beater additives. The technical program is to start at 2:00 p.m. with discussions on elastomers, phenolics, wet and dry strength resins, starches and gums, and mill practices.

Vincent A. Long, technical director of Blandy Paper Co. in Greenwich, N. Y. will serve as moderator. The subject of elastomers will be discussed by Neil H. Sherwood of the B. F. Goodrich Chemical Co. in Avon Lake, Ohio. Phenolics will be discussed by Robert Gager of Synco Resins, Inc. of Danbury, Conn. J. C. Barthel, technical director of the Paper Chemicals Department of American Cyanamid Co. in New York City, will discuss both wet and dry strength resins. The subject of starches and gums will be presented by Arthur M. Goldstein, chief paper laboratory chemist of Stein Hall & Co. in New York City. Mill practices with beater additives will be the subject of Fred R. Ramage of Latex Fiber Industries, Inc. of Beaver Falls, N. Y.

The afternoon session will be followed by dinner at 7:00 p.m. The speaker of the evening will be Fritz Rosenthal, director of product development of Knowlton Bros., Inc. of Watertown, New York.

Everyone working in or any way allied with the paper industry is welcome to attend this symposium.

Pacific Section

The Pacific Section of the Technical Association of the Pulp and Paper Industry and the Pacific Coast Division of the American Pulp and Paper Mill Superintendents Association are returning to Gearhart, Ore., on the Oregon Coast for their joint spring meeting May 21–23. The convention will be headquartered at the Gearhart Hotel.

Paul S. Billington, Weyerhaeuser Timber Co., Longview, Wash., chairman of the TAPPI Section, and Frank R. Hamilton, chairman of the APPMSA Division, are co-chairmen of the meeting. TAPPI's technical program is in the hands of Norval Magnusson, Puget Sound Pulp & Timber Co., Bellingham, Wash., who has announced that the theme will be, "Multiple Water Usage." Glen D. King, Crown Zellerbach Corp., West Linn. Ore., is organizing the APPMSA

program around the theme, "New Slants on Quality." Speakers and their papers will be announced later.

Pre-registration will again be used, and hotel and motel rooms will be reserved by the housing committee on the basis of preregistrations. Registration forms and program information will be mailed early in April, according to Miss Kay Fralick, Morden Machines Co. convention secretary, and registration forms can be obtained from her office, 3420 S. W. Macadam Ave., Portland, Ore., after April 1.

The general program is adapted to the locale of the meeting. Thursday, May 21—registration, buffet supper; Friday, May 22—technical meetings, men's luncheon, ladies' golf, with the day topped off with an informal Hawaiian-theme buffet supper and dance; Saturday, May 23—men's breakfast, technical session, men's golf, ladies' luncheon and entertainment; and in the evening, an informal banquet and dance.

Officers of the two associations serving on the general committee include, for APPMSA, Louis W. Pumphrey, Westminister Paper Co. Ltd., New Westminister, B. C.; A. Hugh Wickett, Weyerhaeuser Timber Co., Longview, Wash.; R. Burke Morden, Morden Machines Co.; and for TAPPI, Robert H. Smythe, Ray Smythe Co., Portland.

Committee chairmen are—arrangements, A. B. Jerabek, Drew Engineering Co.; entertainment—B. Don Hartel, The Black-Clawson Co.; golf—Jack D. Gilberg, General Chemical Corp.; housing—Jack Weiblen, Columbia River Paper Mills and Roy D. Keller, F. C. Huyck & Sons; ladies—Mrs. W. A. Salmonson, the W. A. Salmonson Co., and Frederick H. Ihlenburg, Draper Brothers Co.; Wake-'em-Up Breakfast skit—F. Thomas King, National Starch Products, Inc.; Get-Together party—Gordon Petrie, The Black-Clawson Co.; and registration—Paul J. Pernice, General Aniline and Film Corp.

A.I.E.E. Pulp and Paper Conference

The annual conference of the Pulp and Paper Industry Subcommittee of the American Institute of Electrical Engineers will be held at the University of Maine, Orono, Me., on June 18–19, 1959.

Technical papers concerning electrical application in the pulp and paper industry will be presented.

Second Cellulose Conference

The Second Cellulose Conference will be held at the Cellulose Research Institute, State University College of Forestry, Syracuse, N. Y., on May 7 and 8, 1959.

Thursday, May 7

9:00 a.m. Registration—Marshall Hall

Morning Session

9:30 J. K. N. Jones—Queens University, Kingston, Ont., "Structure of Some Water Soluble Polysaccharides"

10:10 T. J. Painter and T. E. Timell—Pulp and Paper "Enzymatic Hydrolysis of a 4-*o*-Methyl Glucuronoxylan from White Birch"

10:45 R. H. Marchessault and B. G. Ranby—American Viscose Corp., Marcus Hook, Pa., "Weak Links in Cellulose"

11:30 H. Sihtola—Finnish Pulp and Paper Research Institute, Helsinki, Finland, "Reasons for the Yellowing of Pulp"

12:10 Luncheon

Afternoon Session

1:45 C. Y. Liang and R. H. Marchessault—American Viscose Corp., Marcus Hook, Pa., "Structure and Conformation in Native and Mercerized Celluloses"

2:25 I. Jullander—Mo och Domsj. Ltd., Ornsköldsvik, Sweden, "Borohydride Reduction of Pulps"

3:05 D. Vermaas—N. V. Onderzoekings Instituut Research, AKU, Arnhem, Netherlands, "The Xanthation Reaction and the Ripening of Xanthates"

3:50 E. W. Abrahamson, I. Panik, and K. Sarkanen—State University College of Forestry and Cellulose Research Institute, Syracuse, N. Y., "Spectroscopy and Photochemistry of Cellulose Tendering Dyes"

4:30 N. Geacintov—Cellulose Research Institute, Syracuse, N. Y., "Grafting onto Cellulose, Using U V Irradiation"

Evening: Banquet

Friday, May 8

Morning Session

9:30 K. Ward, Jr.—The Institute of Paper Chemistry, Appleton, Wis.

10:15 C. M. Conrad and D. J. Stanonis—Southern Regional Research Laboratory, New Orleans, La., "Mechanical Properties of Doubled Cotton Yarns Cyanoethylated without Tension"

11:00 G. Hebblewaite, R. F. Schwenker, Jr., and E. Pacsu, Textile Research Institute, Princeton, N. J., "6-Thio Derivatives of Cellulose and α-Glucose"

The meeting is expected to be terminated about noon.

A registration fee of $5.00 should be enclosed with the application for attendance. Make hotel and travel reservations well in advance of the meeting. Participants who expect to be accompanied by their wives are requested to inform Miss J. Pelchy, Cellulose Research Institute, State University College of Forestry, Syracuse 10, N. Y. Phone: GR 6-3151, Ext. 283.

Tenth Coating Conference

The Tenth Coating Conference of the Technical Association of the Pulp and Paper Industry will be held at the Statler-Hilton Hotel, Boston, Mass., May 25-27, 1959. Reservations for sleeping accommodation should be made directly with the hotel.

Sunday, May 24, 1959

3:00 p.m. Registration.

Monday, May 25, 1959

8:00 a.m. Coating Committee meeting.

10:30 a.m. Opening Remarks

Frank Kaulakis, Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis., and J. T. Loomer, Continental Can Co., Robert Gair Div., New York, N. Y.

10:45 a.m. First Technical Session

Paul Plante, St. Regis Paper Co., Deferiet, N. Y., *chairman.*

1. "Progress Report No. 2—TAPPI Project 600," by J. V. Robinson, The Mead Corp., Chillicothe, Ohio.
2. "The Interpretation of Statistical Data Obtained in the Coating Process," Robert C. Chase, University of Maine, Orono, Me.

1:30 p.m. Second Technical Session

L. A. Gilbertsen, Marathon Corp., a division of American Can Co., Menasha, Wis., *chairman.*

3. "The Kohler Coating Method," by J. R. Gunning, Provincial Paper Ltd., Georgetown, Ont., and John B. Kohler, Consulting Engineer, Woodstock, Ill.
4. "The Comparison of the Air Doctor and

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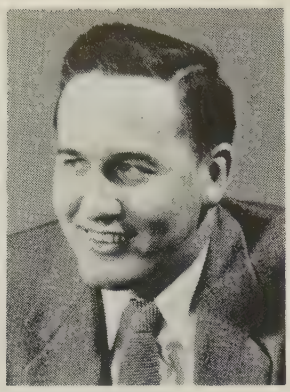
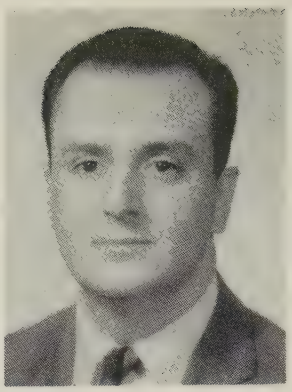
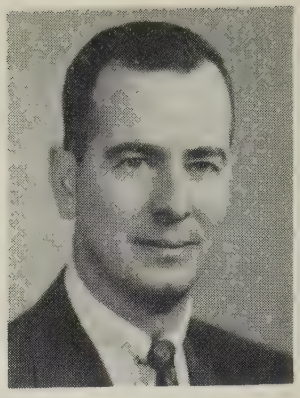


R. W. Hagemeyer, Wyandotte Chemicals Corp., Program Chairman, Tenth Coating Conference



F. Marchette, Titanium Pigment Corp., Treasurer, Tenth Coating Conference



G. E. Hall, Wyandotte Chemicals Corp., Publicity Chairman, Tenth Coating Conference

Blade Coater," by George Booth, Black-Clawson Co., Inc., Dilts Division, Fulton, N. Y.

5. "New Coating Preparation at Blandin Paper Company," by C. A. Richardson, Blandin Paper Co., Grand Rapids, Minn.
6. "The Optical Efficiency of Titanium Dioxide Pigments in Paper Coating," by F. R. Marchetti and W. R. Willets, Titanium Pigments Corp., New York, N. Y.
7. (Paper by Minerals and Chemicals Co.—no title as yet), Wade Claxton, Minerals & Chemicals Corp. of America, Menlo Park, N. J.

Tuesday, May 26, 1959

9:00 a.m. Panel Symposium on Coatings: Past, Present, and Future. ARTHUR W. NEUBAUER, Crown-Zellerbach Corp., Camas, Wash., *moderator.*

"Coatings Past"—N. I. Bearse, Oxford-Champion, Lawrence, Mass.

"Board Coating"—W. H. Aiken, Diamond-Gardner Board & Carton Co., Middletown, Ohio.

"Coatings Present"—Harold Annis, Oxford Paper Co., New York, N. Y.

"Coatings Future"—Paul Thoma, Time, Inc., Springdale, Conn.

1:30 p.m. PLANT TRIPS

1. Dewey and Almy Chemical Division, Cambridge, Mass.
2. Nashua Corp., Nashua, N. H.
3. Oxford-Champion, Lawrence, Mass.

Wednesday, May 27, 1959

9:00 a.m. THIRD TECHNICAL SESSION

CHARLES WHELPTON, The Champion Paper and Fibre Co., Hamilton, Ohio, *chairman.*

8. "The Effect of Styrene-Butadiene Ratio on the Properties of Clay Coated Papers," by H. C. Carlson, Koppers Co., Inc., Pittsburgh, Pa.
9. "Study of the Water Retention of Latex Bound, Clay Coating Colors," by C. W. Cairns, Dow Chemical Co., Midland, Mich.
10. "Microparticle Size Vinyl Acetate Copolymer Emulsion as Economical; Low Odor, Clay Coating Binder," by N. Tompkins, Dewey; Almy Chemical Co., Cambridge, Mass.
11. "High Amylose Cornstarch—Properties and Prospects," by F. R. Senti, U. S. Dept. of Agriculture, Peoria, Ill.
12. "Cationic Starches as Paper Coating Binders," by D. S. Grief, National Starch Products, Inc., Plainfield, N. J.

12:00 Noon ANNUAL LUNCHEON

F. M. KAULAKIS, Consolidated Water Power & Paper Co., Wisconsin Rapids, Wisconsin, *chairman.*

Guest Speaker: Stanton Mead, President, Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis.

2:30 p.m. FOURTH TECHNICAL SESSION

H. J. CONNELL, S. D. Warren Co., Cumberland Mills, Me. *chairman.*

2:30 p.m. FOURTH TECHNICAL SESSION (*Contd.*)

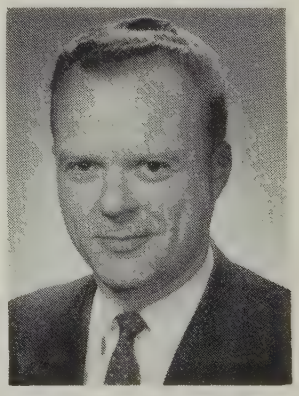
13. "Experience with Control Charts on Ink-Film Thickness and Sharpness," by W. L. Rhodes and J. Petrycki, Rochester Institute of Technology, Rochester, N. Y.
14. "Penetration Controlling (or Water Retention) Properties of Colloid Additives," by A. Miller, Kelco Co., San Diego, Calif.
15. "Rheological Properties of Suspensions and of Polymeric Solutions," by A. B. Metzner, University of Delaware, Newark, Del.

Eighth Statistics Course

Dartmouth College in New Hampshire is the site of the Eighth Pulp and Paper Statistics Course, July 20–31, 1959.

Specific paper industry application of statistical methods will be the prime consideration in both the elementary course and the advanced seminar. The two courses will run concurrently for the two-week period.

R. E. Kilty, A. E. Staley Mfg. Co., Local Arrangements Chairman, Tenth Coating Conference



K. E. Vroom, Pulp & Paper Research Institute of Canada, Chairman, Eighth Statistics Conference

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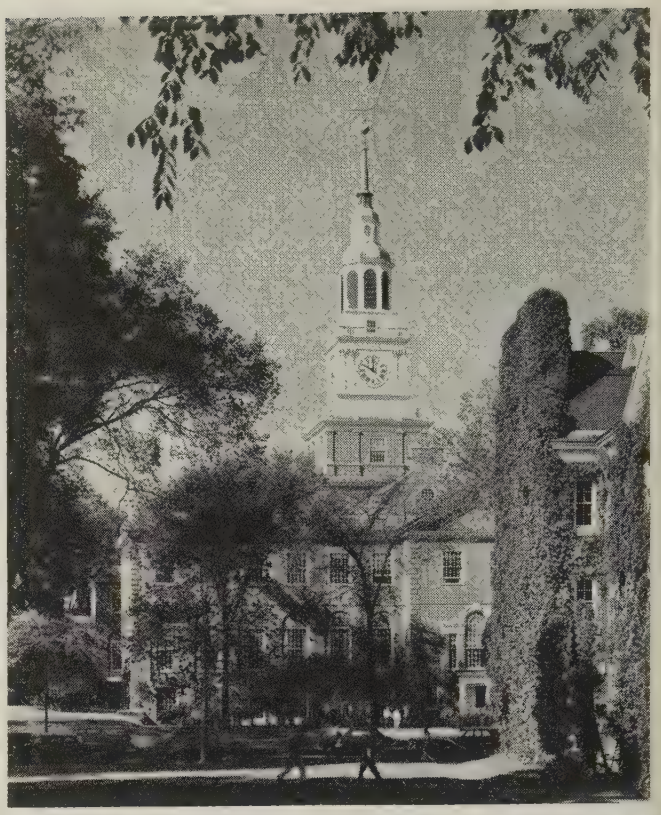

Baker Library at Dartmouth College, Site of the Eighth Statistics Conference

The Elementary Course is intended for people with little or no previous formal training in statistics. Subjects will be: Significance tests, Regression, Correlation, Analysis of variance, and Design of experiments. The text, Davies' "Statistical Methods in Research and Production," will be sent to each registrant well in advance to permit individual preparation prior to the course.

The Advanced Seminar is for experienced people who wish training in special problems. Laboratory sessions will be devoted to specific industry problems brought in by registrants. Multiple regression, analysis of variance, and design of experiments will be stressed. Davies' "Design and Analysis of Industrial Experiments" will be sent to registrants in advance.

Enrollment is limited to 40 in the elementary and 15 in the advanced course, so intending registrants are urged to apply as early as possible. Early registrants will also bring the textbook to the student in time to permit advance preparation.

Fee, including instruction, text, course material, board and lodging, is $280 for either course.

Applications or requests for information should be sent to A. J. Winchester, TAPPI, 155 East 44th St., New York, N. Y.

Outline of Lectures

ELEMENTARY COURSE

I. Formal lectures will, in the first week, be presented as follows:

Simple Linear Regression—Regression is presented as a means of investigating and estimating the relationship between a result and some possible factor.

Correlation Coefficient—Measurement of the intimacy of a relationship is made with a correlation coefficient.

Partial Correlation Coefficient—The difficulties of dealing with a result that depends on two factors are met by using partial correlation.

Significance of Regressions and Correlations—The *t*-test is

introduced and compared with the test of a correlation coefficient.

Multiple Regression—The problem of dealing with a result that depends on two or more factors is further discussed.

Curvilinear Regression—Curvature of the response to a single factor is considered.

Design of Experiments—Practical measures necessary in securing data amenable to the above operations are discussed.

In the second week there will be presented lectures as follows:

Tests of Significance of a Difference—The problem of testing significance of a difference between two series of tests is presented as a *t*-test.

Analysis of Variance—The general subdivision of variability is presented as an extension of the *t*-test.

Analysis of Variance with Two-Way Classification—The subdivision of variability is further extended to the common practical case of two-way classification.

Analysis of Variance with Unbalanced Data—Problems of groups of dissimilar size are discussed. The special case of missing plots is treated.

Analysis of Variance with Three or More Experimental Factors—The procedure for two-way classification is generalized.

The Role of Replication—Replication is treated as a special factor; its role in experimentation is discussed.

Design of Experiments—Practical measures necessary in securing data amenable to analysis of variance are discussed.

II. Assigned laboratory excerises will follow and illuminate each of the topics discussed in formal lectures. About as much time will be spent on these as at lecture. The instructors will be present to take up the problems in a personal way. The illustrative material will be data from problems in the Pulp and Paper Industry.

III. Something less than half the working day will be left free of formal lectures and assigned laboratories. This time will be filled in two ways. First, discursive lectures will be given for those who come to the Conference so well equipped that they readily keep up with the formal program. These lectures will be set up as occasion or request requires. Secondly, there will be, as required, review and consolidation sessions for those so equipped that they find difficulty in keeping abreast the formal program.

Advanced Seminar

The seminar sessions will consist largely of specific and somewhat involved problems, and each participant will be requested to bring with him statistical problems for discussion by the group as a whole. The instructors will be there to guide the discussions, and to take up as necessary some of the finer points of statistical methods. In addition, the instructors will give informal talks on a variety of topics.

With such a program, it is not possible to give exact details of the proceedings of the seminar. However, some of the topics which have been discussed in previous years may be a guide to the content of this section of the course.

A. Comparison of results and interpretation by regression in contrast to analysis of variance.

B. Experimental analysis by use of contingency.

C. Effect in analysis of normalizing transformations.

D. Use of the negative binomial.

E. Sequential analysis.

F. General problems in experimental design—such as randomization, replication, the design itself, error, power of the test.

G. The relationship of statistical quality control to analysis of variance.

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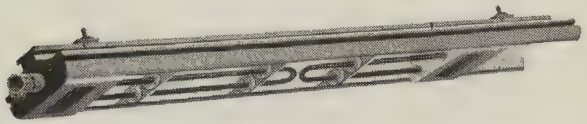

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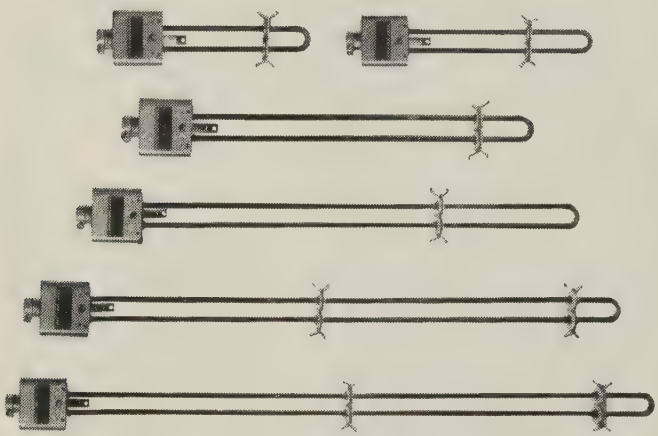

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H. Problems of interpretation of results of multiple regression analysis.

I. The problems of overall indexesof product quality.

J. Operation of the doctrine of steepest ascent and difficulties in the Boxonian approach.

Tenth Testing Conference

The Tenth Testing Conference of the Technical Association of the Pulp and Paper Industry will be held Aug. 17–21, 1959, at the Multnomah Hotel, Portland, Ore.

A special feature of the conference will be a panel discussion on pulp evaluation. Roy P. Whitney, dean, The Institute of Paper Chemistry, Appleton, Wis., will be moderator of this discussion, which will feature a group of recognized authorities in the field of pulp evaluation.

The conference will include two days of technical sessions, visits to local pulp and paper mills, testing committee meetings, and a logging trip.

Curtis M. Walseth, Wyerhaeuser Timber Co., Cosomoplis, Wash., is general chairman of the meeting, and the technical

Meeting of the Testing Conference Committee which was held in New York, N. Y., Feb. 25, 1959. Attending were: Messrs. Chapman, Christoferson, Brandon, Arken, Walseth (standing), Winchester, Dobbins (standing), Hobbs, Obenshain, and Wehmer

program is being arranged by S. M. Chapman, Pulp & Paper Research Institute of Canada, Montreal, Que. Local arrangements are being made by a West Coast Committee under Frank Caskey, Morden Machine Co., Portland, Ore J. L. McClintok, Meyerhaeuser Timber Co., Longview, Wash., is publicity chairman. Miss Kay Fralick of Morden Machine is secretary of the conference committee.

A small exhibit of testing instruments is planned in connection with the meeting under the chairmanship of Fred Bachelder, Testing Machines, Inc., Mineola, L. I., N. Y.

Reservations for sleeping accommodation should be addressed to the Multnomah Hotel, Portland, Ore.

Fiber Attraction and Bonding Symposium

A symposium on the Fundamentals of Fiber Attraction and Bonding will be held at The Institute of Paper Chemistry, Appleton, Wis., Sept. 9–11, 1959. This symposium is jointly sponsored by the Wet Strength and Interfiber Bonding and Fundamental Research Committees of TAPPI.

Co-chairmen of the conference are Roy P. Whitney and John W. Swanson, The Institute of Paper Chemistry, Appleton, Wis. The technical program is being developed under the chairmanship of R. N. Griesheimer, Mead Corp., Chillicothe, Ohio. Mr. Greisheimer is being assisted by the chairmen of the individual half-day sessions as indicated in the tentative program given below.

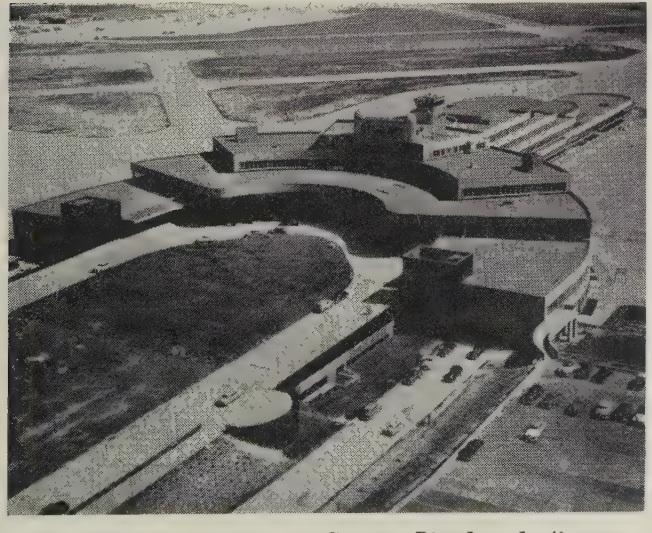
PROGRAM

1. Principles of Adhesion
   Roy P. Whitney, Institute of Paper Chemistry, Appleton, Wis., *chairman*
   (a) Fundamentals of adhesion.
   (b) Structural aspects of adhesion.
   (c) Flocculation in dilute fiber suspensions.
2. Development of Wet Web Strength
   R. N. Griesheimer, Mead Corp., Chillicothe, Ohio, *chairman*
   (a) Fiber agglomeration and dewatering.
   (b) Wet web strength.
   (c) Adhesion of wet webs to other surfaces.
3. Fiber Properties Affecting Adhesion
   G. K. Dickerman, Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis., *chairman*
   (a) Flexibility of fibers.
   (b) Fiber swelling and swollen specific volumes.
   (c) Drying and shrinkage.
4. Development of Bonds
   R. A. A. Hentschel, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., *chairman*
   (a) Mechanism of bonding.
   (b) Fiber surface and bonded area.
   (c) Role of moisture.
   (d) Bonding in synthetic fiber papers.
5. Role of Additives in Bonding
   K. W. Britt, Scott Paper Co., Chester, Pa., *chairman*
   (a) Polysaccharide adhesives.
   (b) Mechanism of retention of resin additives.
   (c) Klastomeric binders.
6. Panel discussion and Summary
   J. W. Swanson, Institute of Paper Chemistry, Appleton, Wis. Panel to be composed of speakers at previous sessions.

Information concerning registration for the symposium will appear in the May issue of *Tappi*.

Fourteenth Engineering Conference

For the first time in more than a decade of national engineering conferences representatives of the Engineering Division of the Technical Association of Pulp and Paper Industry (TAPPI) will hold their annual technical meeting in Pittsburgh. It is significant that upwards of 1000 representatives expected to be in attendance will mark the occasion during the year in which more than a million and a half residents of the Pittsburgh area are celebrating the city's 200th birthday anniversary.



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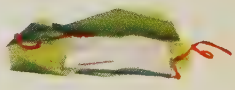

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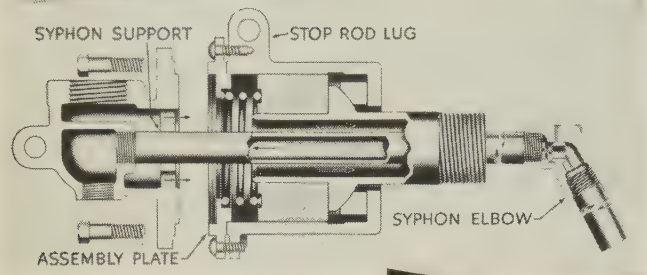

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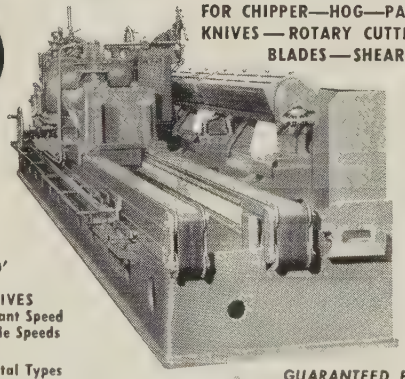

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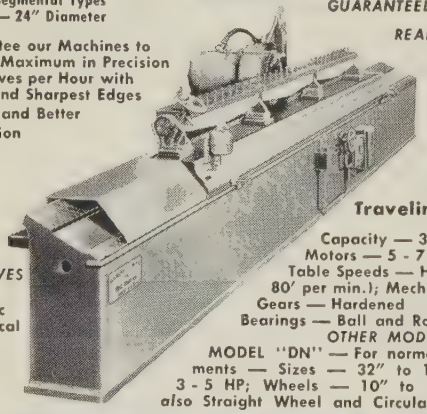

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Quite appropriate, too, that TAPPI has decided to hold its 14th Engineering Conference on October 12–15 in Pittsburgh, which today is recognized as the most dynamic city in America, renascent physically and culturally, and in an atmosphere that is vital and inspirational to TAPPI members.

Convention headquarters will be the Penn-Sheraton Hotel which faces Mellon Square, a magnificent acre of greenery. Here in the heart of the city's famed "Golden Triangle" is a centerpiece of majestic trees and shrubs, erupting fountains and cascades, Venetian terrazzo and underground parking, with no peer in the nation.

Also fronting on the Square are the 31-story Alcoa building, the world's first all-aluminum skyscraper which blazed the way for other similarly constructed buildings, and the U. S. Steel-Mellon building which towers 41 stories. Other buildings which further accentuate the imposing downtown Pittsburgh skyline include the Koppers, Grant, Equitable Gas, Union Trust, Oliver, and Pittsburgh's tallest office building, the 44-story Gulf building with its flashing weather bureau.

Pittsburgh, known as the "Gateway to the West" during the early history of our country, has played a leading role in the conquest of the wilderness and today has become known as the hub of the world's heavy industry. The Pittsburgh area is the home of the world's largest manufacturer of aluminum, steel, steel rolls, rolling mill machinery, air brakes, plate and window glass, lifting jacks, safety equipment. It is the location of the world's largest tinplate producing unit, by-product coke plant, wire manufacturing plant, food products plant of its type and second largest electrical equipment plant, operating unit in the steelmaking industry. Also, America's largest producer of bolts, nuts and rivets, wrought iron pipe and bituminous coal. Many of these manufacturing facilities in some fashion or another, become associated with TAPPI.

In late 1957, Pittsburgh had dedicated the world's first full-scale plant using atomic fuel to produce electricity. Largely

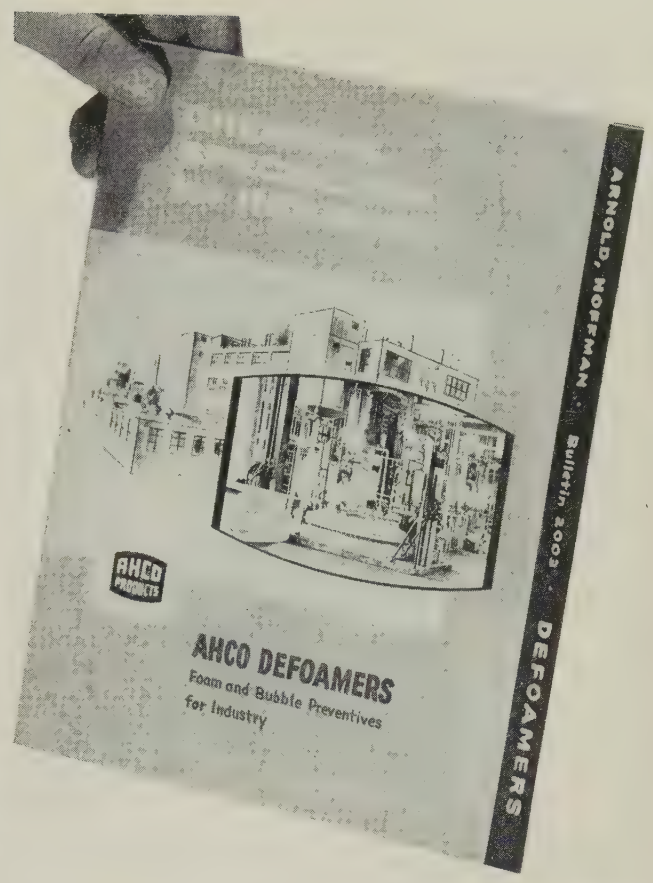
The Alcoa Building was departure from the use of conventional materials for skyscrapers. The Aluminum Co. of America, a pioneer in the field, occupies this dramatic 3-story structure that blazed the way for construction of other similarly-faced buildings

due to the research efforts of a Pittsburgh corporation which built the reactor for the new power station in Pittsburgh's suburban Shippingport, the city has gained world recognition for its commercial application of the atom.

Now celebrating its Bicentennial during 1959, the city is continuing to move ahead with its unprecedented $2-billion program of growth and development which had its origin nearly a decade ago. At the juncture of the Allegheny and Monongahela Rivers which merge to form the Ohio River, today stands the city's new Point Park and Gateway Center which have spearheaded the Pittsburgh Renaissance. During this stirring renascent era, 51 new buildings have appeared on the Pittsburgh scene, more than 5000 off-street parking spaces built, the magnificent parks created and nearly a fourth of the 315 acres in the downtown area reconstructed. Merchants have spent millions cleaning their buildings of old grime.

Contrasting with the city's historic landmark, the Fort Pitt Block House, erected in 1760, are the three gleaming stainless steel-clad buildings of Equitable Life Assurance Society. Other recently constructed skyscrapers in this modern Gateway Center include the Bell Telephone Company and the Commonwealth's 16-story office building which is one of the first structures in the world to use colored aluminum-skinned panels. Scheduled for completion in this area within the next year or two are the 800-room Hilton Hotel and Equitable's fourth Gateway office building.

Pittsburgh's cultural and recreational attractions to name a few, include the Carnegie Art Institute, Carnegie Museum and Library, Syria Mosque, Stephen Collins Foster Memorial, Phipps Conservatory, and the impressive world famous Mellon Institute of Research whose facilities are relied on by many technical societies. These, and other leading Pittsburgh institutions of learning and medical centers, are located in Pittsburgh's Oakland section which is only a few minutes



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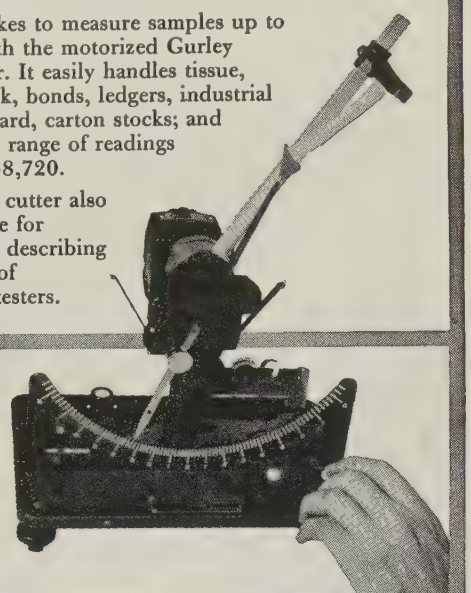


W. & L. E. Gurley
Station Plaza & Fulton Sts., Troy, N. Y.

ride from TAPPI's convention headquarters in the Penn-Sheraton Hotel.

Deemed just as essential as off-street parking in the solution of traffic problems are new highway arteries. The State has presently under construction a $140-million nontoll expressway which will carry autos and other vehicles nonstop from the east suburbs, through downtown, to the west suburbs. The parkway will also provide easy, direct access to the new western extension of the Pennsylvania Turnpike, a project which in itself has reduced congestion downtown by enabling through traffic to skirt the city. The parkway ends in the west at an interchange which leads to the new Greater Pittsburgh Airport—a $33-million airport which is the second largest in the world. Plans are now under way to equip the airport as a jet terminal with an $8,000,000 runway to be completed during 1960.

In addition to construction of modern transportation facilities and office buildings, an equally important phase of Pittsburgh's Renaissance has been the elimination of hundreds of slums and blighted areas for an all-weather combination civic auditorium-sports arena featuring an architectural innovation, a unique retractable roof.

Large scale expansion and renovation programs, amounting to more than a billion dollars, have been undertaken by Pittsburgh industries and businesses during the last decade. Gleaming new research centers dotting the city's outskirts today establish Pittsburgh as one of the world's great industrial research capitals. No less than 50 major research centers, among them, Pittsburgh Plate Glass Company, Gulf, Alcoa, Jones and Laughlin Steel, United States Steel, Westinghouse, H. J. Heinz, Koppers, Allegheny Ludlum, and many others, now circle a 30-mile range of the city.

Such buildings—whether pyramids, cathedrals or skyscrapers—have been significant milestones of the past decade of Pittsburgh's Renaissance which has stirred imaginations throughout the world and inspired civic leaders in other American metropolitan centers to similar undertakings. What actually began nearly a decade ago as smoke abatement and flood control programs—two of the city's age-old enemies —Pittsburgh's Renaissance apparently is without end, just as there is no ending the constant renovation of any established American community.

Alkaline Pulping Committee

David Wetherhorn, Southern Paperboard Corp., Port Wentworth, Ga., has been appointed vice-chairman of the Alkaline Pulping Committee according to an announcement by M. B. Pineo, Brunswick Pulp & Paper Corp., Brunswick, Ga., chairman of the Pulp Manufacturing Division.

David Wetherhorn, Southern Paperboard Corp.

Mr. Wetherhorn received a B.E. in Chemistry degree from Vanderbilt University in 1941 and from his graduation date until 1943 he was employed by the Calvert Distilling Co. From 1943 to 1946 Mr. Wetherhorn was in the armed services during which time he attended Johns Hopkins University at night and took courses in advanced evaporation and distillation.

Upon his release in 1946 as first lieutenant in the Chemical Corps Mr. Wetherhorn joined Southern Paperboard Corp. as a shift chemist. He became project engineer in 1951 and was made technical director in July, 1955. Mr. Wetherhorn joined TAPPI in 1949, becoming a member of the Alkaline Pulping Committee in 1951 and served as program chairman for the 1955 Alkaline Pulping Conference in Chattanooga. Mr. Wetherhorn is married and has one son and three daughters. As a hobby he specializes in growing camellias and azaleas.

Graphic Arts Session

An estimated 500 persons filled the East Ballroom of the Commodore Hotel, New York City, to standing room only Wednesday morning, Feb. 25, 1959, to hear of various aspects of "printability" research and testing. The four-paper session, held in conjunction with the 44th Annual Meeting of the Technical Association of the Pulp and Paper Industry was sponsored by its Graphic Arts Committee and chairmaned by J. M. Fetsko, Lehigh University, Bethlehem, Pa.

Pick testing research conducted under a TAPPI grant was the subject of the first paper. W. D. Schaeffer, in collaboration with Miss Fetsko and A. C. Zettlemoyer, described the major features of the project, the objective of which is to recommend a TAPPI standard method for evaluating the surface strength of paper and paperboard. During the first year, eleven pick testers were studied at Lehigh and/or at various laboratories where they exist. A major problem uncovered was lack of reproducibility from day to day as well as from instrument to instrument. Mr. Schaeffer concluded that further work must be directed to elucidating the causes for the variability so that the sources may be eliminated. The cooperation of almost forty paper companies and other industrial and research organizations was cited as evidence of the widespread interest in the project.

A TAPPI research grant also provided the basis for the second paper. G. R. Sears reported on progress made with W. A. Wink on their studies of surface characteristics of paper and paperboard as related to printing smoothness. Both men are staff members of the Institute of Paper Chemistry, Appleton, Wis. A nip spreading technique for obtaining

a roughness index was applied to eight widely different samples. Several modifications in the technique were necessary to handle all the stocks with the same fluid and nip conditions. The roughness index, proof press printability, Chapman smoothness, gloss, surface contour, and formation tests were compared and interrelated. Discrepancies in the smoothness rankings suggested that increased nip loads in the nip-spreading test are required to improve the correlation with printing smoothness.

Practical aspects of smoothness testing particularly for halftone and gravure printing were discussed next by R. O. Ragan, Chicago Carton Co., Chicago, Ill. Mr. Ragan's experience with press performance and with various test procedures led to the conclusion that photomacrographic examination of printing surfaces was a most advantageous method for evaluating smoothness. Finding that conventional photographic techniques were not entirely suitable for quality control, he developed a portable self-contained camera setup. Desirable features include no sample cutting, constant illumination, semifixed focusing, and ready specimen identification. Although high-speed film produced more contrast, Polaroid film is recommended for routine purposes. Photomacrographs were shown which illustrated dramatic differences in surface structure and uniformity on various printed and unprinted stocks.

The session concluded with a discussion on tests for evaluating newsprint quality by R. W. Prince, American Newspaper Publishers Association Research Institute, Easton, Pa. In a study involving over 600 newsprint samples, it was found that smoothness, brightness, and hardness contributed a total of 50 to 60% of the printability of the samples. The statistical correlations were based on the Larocque proof press printability test, which in turn was shown to correlate significantly with printing quality obtained from production press runs. The analyses also suggest that porosity and opacity variations collectively account for 5%, and basis weight variations for another 10%, of the variations in newsprint quality.

James H. Wing, Continental Can Co., Uncasville, Conn., was appointed to succeed Miss Fetsko as Graphic Arts Program Chairman. Sessions in 1960 are planned at the February Annual Meeting in New York City and at the May Coating Conference, Chicago, Ill.

Errata

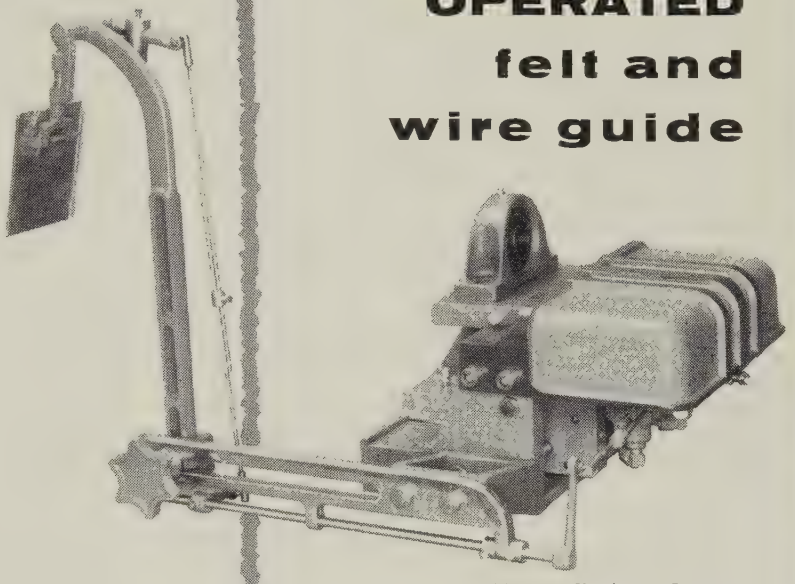
In September issue under the Patent Section, with a subheading "March 11, 1958," a patent number is given incorrectly. The patent covers an absorbent bandage invented by Messrs. Brien and Jones with assignment of the patent to Kimberly-Clark Corp. The number of this patent is given as 2,826,220 instead of 2,826,200.

In the article: "The Application of Statistical Methods in the Pulp and Paper Industry," *Tappi* 41: 184 A (1958), there is an arithmetical error in the computation of the *S.S.* of operators, Table V, page 188 A. The *S.S.* of operators should read 25,892. Accordingly, the square sum of the intersection machines shipment must be changed to 2467, the variance for operators to 12,946 and the variance for machines shipment to 176.2. The *F*-value for operators will then be 73.5. These corrections will not alter the conclusions arrived upon. The author A. G. Schöning, Billerud AB, Säffle, Sweden, is indebted to T. Handa, Sanyo Pulp Co., Ltd., Japan, for drawing his attention to the error mentioned.

In L. Field, P. E. Drummond and P. H. Riggins, with E. A. Jones, *Tappi* 44: 721 (1958), "The Organic Chemistry of Sulphur in the Kraft Process. I. Pine Thiolignin as a Mixture": p. 724, col. 2, line 24—For "3508 of" read "350 g. of."

On page 89 A of the January, 1959, issue of *Tappi*, the author's name is spelled incorrectly. It should be Charles A. Bicking. Also the headings over columns 4 and 5 in Table I, page 90 A, should be 0^2 not σ.

GILBERT and NASH AIR OPERATED felt and wire guide



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Items About New and Old Tappimen

New TAPPI Members

Elio Bedoni, Director of Metallic Fabrics, Stab. G. Fornara; C., Torino, Italy.

Charles E. Bieber, Jr., Chief Engineer, Sterling Pulp & Paper Co., Eau Claire, Wis., a 1936 graduate of Tri-State College.

Carl D. Bockman, Jr., Chemist, Tennessee Eastman Co., Kingsport, Tenn., a 1949 graduate of Northeastern University.

Walter K. Boyd, Assistant Chief, Corrosion Research Div., Battelle Memorial Institute, Columbus, Ohio, a 1945 graduate of Ohio State University.

Herbert J. Brouillette, Mechanical Engineer, St. Joe Paper Co., Port St. Joe, Fla., a 1928 graduate of McGill University.

P. Burford, Technical Librarian, Containers Ltd., Melbourne, Australia.

Douglas C. Burke, Application Engineer, General Electric Co., Richmond, Va., a 1941 graduate of Stanford University.

Gian G. Busnelli, Assistant Chief Engineer, Paper Machine Branch, De Pretto-Escher Wyss S.p.A., Schio, Italy, a 1952 graduate of the University of Padua.

Matthew A. Cattaro, Director of Research and Development, Gardner Laboratory, Inc., Bethesda, Md., a 1950 graduate of Iona College, New York.

Francisque Champ, Director, Cellulose du Maroc, France. Attended the School of Industrial Chemistry, Lyon, France.

G. Andre Charron, Student, University of Maine, Orono, Me.

Hermann Cosack, Chemist, Papierfabrik Baienfurt A.G., Baienfurt/Wurtt., West Germany, a 1956 graduate of the Technical University, Darmstadt.

Ezio Cremoli, Technical Director, Lindeceto Cellulosa Pomilio, Rome, Italy, a 1936 graduate of Milano University.

Luc Dalle, Manager, Etab. Dalle Freres & Co., Bousbecque, Nord, France.

Arthur H. Damon, Quality Control Supervisor, Continental Can Co., Robert Gair Div., Tonawanda, N. Y., a 1951 graduate of New York State College of Forestry.

Charles H. Davis, Mill Manager, Ballarat Paper Mills Proprietary Ltd., Ballarat, Vic., Australia. Attended London University and Battersea Polytechnic.

Raymond J. De Laat, Chemist, Badger Paper Mills, Inc., Peshtigo, Wis., a 1957 graduate of the University of Wisconsin.

David Deretchin, Research Chemist, Dixie Cup Div., American Can Co., Easton, Pa., a 1958 graduate of the College of Forestry, Syracuse University.

Philippe de Sedouy, Engineer, Technical Prospection, Compagnie Pechiney, Paris, France, a 1933 graduate of the Mining School, Paris.

Keith W. Dorman, Assistant Chief, Div. of Forest Management Research, Southeastern Forest Experiment Station, Asheville, N. C., a 1934 graduate of Iowa State College.

Louis Dranikoff, Chief Chemist, Polymer Group, Stein, Hall & Co., Inc., New York, N. Y., a 1941 graduate of Brooklyn College.

Thomas C. Elias, Student, Western Michigan University, Kalamazoo, Mich.

Alfred W. Elkington, Chief Chemist, Bowater-Scott Corp. Ltd., Northfleet, Gravesend, Kent, England, a 1953 graduate of the University of London.

John S. Entwisle, Vice-President, Harry Miller Corp., Philadelphia, Pa. Attended William and Mary College.

Robert C. Etnire, Director of Production, River Raisin Paper Co., Monroe, Mich. Attended Georgia Institute of Technology and Akron University.

Alexander F. D. Ferguson, Manager, Converting Dept., R. & W. Watson Ltd., Linwood, Renfrewshire, Scotland, a 1951 graduate of Glasgow University.

Joseph R. Forrest, Sales Representative, Philadelphia Quartz Co., Philadelphia, Pa. Attended Temple University.

Robert W. Fowells, Assistant Research Chemist, Crown Zellerbach Corp., Camas, Wash., a 1955 graduate of the University of California.

William D. Freeman, Technical Service Director, Monadnock Paper Mills, Inc., Bennington, N. H.

M. Dean Fullerton, New England District Sales Manager, Koppers Co., Inc., a 1942 graduate of Pennsylvania State University.

F. Harold Garrett, Fiber Analyst, The Mead Corp., Chillicothe, Ohio. Attended Capital University and Ohio University.

E. Hughes Gemmill, Engineer, W. & L. E. Gurley, Troy, N. Y., a 1950 graduate of the University of New Hampshire.

James D. Geniesse, Engineering Manager, Scott Paper Co., Everett, Wash., a 1948 graduate of the University of Michigan.

Richard F. Gordon, Plant Superintendent, Line Material Industries, Sherman, Texas, a 1949 graduate of the University of Texas.

Irene Counet, Librarian, Societe Worthington, Paris, France.

Donald G. Griffee, Resident Manager, Lincoln Div., Eastern Fine Paper & Pulp Div., Standard Packaging Corp., Lincoln, Me., a 1942 graduate of the University of Maine.

S. Creed Grumbles, Chemist, Anchor Hocking Glass Corp., Lancaster, Ohio. Attended Morehead State College, Kentucky.

Kenneth R. Hall, Production Manager, Owens Illinois, Paper Products Div., Bradford, Pa., a 1943 graduate of Georgia Institute of Technology.

Wilmer E. Hansen, Supervisor, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., a 1944 graduate of U. S. Naval Academy.

Nils Hartler, Chief Engineer, Central Laboratory, Swedish Cellulose Industry, Stockholm, Sweden, a 1952 graduate of Chalmers College, Gothenberg, with a Ph.D. degree.

Jose A. Islas-Morris, Sales Manager, Industrial Quimica Pennsalt, S.A. de C.V., Mexico, D. F., a 1953 graduate of the National University.

Reinhold Jacobsen, Owner and President, R. Jacobsen & Co., Mayen, Germany, a 1932 graduate of the Technical University.

Helmer E. Jonsson, Engineer, Skanska Attikfabriken A/B, Perstorp, Sweden, a 1946 graduate of Hogre Tekniska Laroverket, Malmo.

Martin J. Kest, Sales, National Pulp & Paper Co., Inc., New York, N. Y., a 1949 graduate of Bucknell University.

Shuichiro Kimoto, Director, Research and Development Laboratories, Yoshihara Oil Mill Ltd., Nishinomiya City, Hyogo Pref., Japan, a 1936 graduate of Tokyo University.

Cornelis P. Kool, Chief Chemist, West Virginia Pulp &

Paper Co., Covington, Va., a 1944 graduate of the Sugar-industry College, Amsterdam, Holland.

Andres Krecic, Chief, Technical Dept., Schcolnik S.A.I.C., Buenos Aires, Argentina, a 1941 graduate of the Railway Technical College.

John R. Lacroix, Managing Director, L. Lacroix Fils S.A., Paris, France, a 1948 graduate of the Central College of Paris.

Aksel N. Larsen, Managing Director, Dansk Lin- og Celluloseindustri A/S, Grenaa, Denmark, a 1942 graduate of the Royal Agricultural College, Copenhagan.

John J. Lee, Supervisor, Paper Control Dept., Gravure Div., Triangle Publications, Inc., Philadelphia, Pa.

Robert A. LePage, Manager, Abrasive Laboratory Development, Minnesota Mining & Manufacturing Co., St. Paul, Minn., a 1949 graduate of the University of Wisconsin.

Lewis J. Lucky, Superintendent, Pulp Mill, Southern Paperboard Corp., Port Wentworth, Ga.

Jose Ludvik, Plant Director, Schcolnik S.A.I.C., Buenos Aires, Argentina.

Francis J. Manning, Plant Manager, Dairypak Butler, Inc., Cleveland, Ohio.

Daniel Marsden, General Manager, Albert E. Reed & Co. Ltd., London, England.

Maurice J. Maynard, Jr., Engineer, Union Bag-Camp Paper Corp., Savannah, Ga., a 1957 graduate of the University of Notre Dame.

Arthur C. McCain, President, Ortman-McCain Co., Chicago, Ill. Attended Northwestern University.

Kermit C. McQueen, Plant Superintendent, Container Corp. of America, Fernandina Beach, Fla.

Richardo Mejenes Q., Chemical Engineer, Fabricas de Papel de San Rafael y Anexas S.A., Mexico, D. F.

Philip D. Mickle, Director of Purchases, Columbia Box Board Mills, Inc., Chatham, N. Y., a 1938 graduate of Cornell University.

John W. More, Research Chemist, Courtaulds Ltd., Viscose Research Laboratory, Coventry, England, a 1940 graduate of Leeds University.

Robert W. Morgan, Coatings Development Chemist, The Dow Chemical Co., Midland, Mich., a 1952 graduate of the University of California.

Desmond Morton, Assistant Chief Mill Chemist, A. E. Reed & Co. Ltd., Tovil, Maidstone, Kent, England. Attended Leeds University.

Harold R. Odom, Engineer, St. Joe Paper Co., Port St. Joe, Fla., a 1951 graduate of the University of Florida.

Robert Osmalov, Technical Superintendent, E. I. du Pont de Nemours & Co., Inc., Richmond, Va., a 1939 graduate of Georgia Institute of Technology.

Oliver A. Panico, Technical and Commercial Manager, Luzzatte & Figlio, Paris, France.

John G. Peters, Manager, Technical Control, Downingtown Paper Co., Downingtown, Pa. Attended Grove City College.

Aldon E. Peterson, Research Chemist, Crown Zellerbach Corp., Camas, Wash., a 1950 graduate of the College of Puget Sound.

William T. Philley, Pulping Leader, Gulf States Paper Corp., Tuscaloosa, Ala.

Josephus T. Popelier, Managing Director, Transgraphic, Wassenaar, Holland. Attended Papermakers Institute of Delft T.N.O.

Joseph P. Powell, Pulp Manufacturing Superintendent, St. Regis Paper Co., Deferiet, N. Y.

Ludwig Ragossnig, Technical Manager, Zellstoff-und Papierfabrik Frantschach A.G., Karnten, Austria, a 1949 graduate of the University of Graz with a Ph.D. degree.

Althea I. Ragsdale, Librarian, Arizona State College, Flagstaff, Ariz.

Fred Randall, Director, Packaging Laboratories, Fabricon Products Div., Eagle Pitcher Co., River Rouge, Mich. Attended Brevard College and the University of Michigan.

Franz J. Reitter, Planning Engineer for Pulp Mill, Krauss-Maffei-Imperial G.m.b.h. & Co., Munchen-Obermenzing, West Germany, a 1948 graduate of the Technical Institute.

Ted L. Robinson, Student, North Carolina State College, State College, N. C.

Russell N. Rust, Electrical Engineer, St. Joe Paper Co., Port St. Joe, Fla., a 1931 graduate of Georgia Institute of Technology.

Harold M. Satisbury, Technical Director, St. Regis Paper Co., Bucksport, Me., a 1935 graduate of Colby College.

John A. Sallack, Chief Chemist, New York ; Pennsylvania Co., Inc., Johnsonburg, Pa., a 1952 graduate of Pennsylvania State University.

Richard L. Savage, Project Engineer, Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis., a 1949 graduate of New York State Agricultural and Technical Institute.

Sylvia G. Schmidt, Patent Supervisor, Maschinenfabrik zum Bruderhaus, Reutlingen/Wurtt., Germany, a 1947 graduate of the Technical University, Darmstadt.

David W. Schulkind, President, The Lawson Co., New York, N. Y.

James R. Sechrest, Jr., Chief Technologist, Champion Paper & Fibre Co., Canton, N. C., a 1928 graduate of North Carolina State College.

Merle J. Showalter, Chemist, Armstrong Cork Co., Lancaster, Pa., a 1942 graduate of Gettysburg College.

Kaj V. Skogberg, Superintendent of Paper Mill, Nokia Aktiebolag, Nokia, Finland, a 1955 graduate of Helsinki Institute of Technology.

John Slajer, Jr., Mechanical Engineer, St. Joe Paper Co., Port St. Joe, Fla., a 1942 graduate of the University of Oklahoma.

Robert E. Stutz, Research Chemist, Western Pine Association Research Library, Portland, Ore., a 1950 graduate of the University of Wisconsin.

Rikard W. Sundblad, Chief Engineer, Wikmanshytte Bruks AB, Vikmanshyttan, Sweden.

Clifton C. Sutton, Laboratory Director, General Foods Corp., Research Center, Tarrytown, N. Y., a 1942 graduate of Cornell University.

Paul R. Templin, Chemist, J. R. Short Canadian Mills Ltd., Toronto, Ont., Canada, a 1952 graduate of the University of Manitoba.

Edward J. Tierney, Director, Quality Control & Research, The U. S. Printing & Lithograph Co., Norwood, Ohio.

Roger L. Traxler, Process Control Engineer, Marinette Paper Co., Ford Edward, N. Y., a 1949 graduate of Bucknell University.

Maurice A. Waddell, Jr., Coating Chemist, Riegel Paper Corp., Acme, N. C., a 1955 graduate of High Point College.

William S. Wagner, Manager of Organic Research, Fiber Products Research Center, Inc., Beaver Falls, N. Y., a 1952 graduate of the University of Missouri with a Ph.D. degree.

Michael E. White, Assistant Paper Mill Manager, Wycombe Marsh Paper Mills Ltd., High Wycombe, Bucks., England, a 1954 graduate of Slough Technical College.

Charles A. Winters, Research Engineer, Diamond Gardner Corp., Ogdensburg, N. Y., a 1955 graduate of Clarkson College of Technology.

Leonard M. Zyzyck, Chief Chemist, Stein, Hall Co., Inc., New York, N. Y., a 1938 graduate of Fordham University.

TAPPI Notes

Albert W. Ayles, formerly of Morningstar, Paisley Inc., is now Manager of the Paper Chemicals Dept., Wica Chemicals, Inc., Charlotte, N. C.

Norman I. Bearse is now Mill Manager of the Oxford Paper Co., Lawrence, Mass.

A. L. M. Bixler is now Manager of Manufacturing Services for Riegel Paper Corp., Acme, N. C.

Dennis M. Bornath, formerly chemist for Marron Laboratories, is now with Charles Bruning Co., Inc., Mt. Prospect, Ill.

Robert E. Bowen of the Continental Can Co. Paperboard Division has been transferred from Hopewell, Va., to Hodge, La., as Assistant Manager.

James E. Brennan, formerly student at Lowell Technological Institute, is now Technical Director of Grace y Cia, Arecibo, Puerto Rico.

Harry J. Buncke, Vice-President in Charge of Engineering for Oxford Paper Co., has transferred his office from Rumford, Me., to New York, N. Y.

Raymond C. Bullock, formerly of Ecusta Paper Co., is now Pulp Mill Superintendent for W. R. Grace y Cia, Arecibo, Puerto Rico.

Frederick C. Came, industrial engineer for Union Bag-Camp Paper Corp., has been transferred from Savannah, Ga., to New York, N. Y.

Jack Chinn is now Assistant Paper Machine Superintendent for the Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis.

E. Way Clarke is now Vice-President of Knowlton Brothers, Watertown, N. Y.

Harry B. Conner is now Assistant Paper Mill Manager for Oxford Paper Co., Rumford, Me.

William M. Crammer, formerly of the Mead Corp., is now Staff Consultant for Rust Engineering Co., Pittsburgh, Pa.

Ray F. Cuyle, formerly of the Scott Paper Co., is now General Superintendent of Tennessee River Pulp & Paper Co., Counce, Tenn.

Rodger M. Dorland, Director of Research for Abitibi Power & Paper Co., has been transferred from Toronto, Ont., to Saulte Ste. Marie, Ont.

Arthur C. Dreshfield, formerly of the Chicago Testing Laboratory, is now Director of Paper Research and Development for the Glidden Co. Pigments Div., Baltimore, Md.

C. Joseph Eisener, formerly of Minnesota & Ontario Paper Co., is now a control engineer for Dryden Paper Co., Dryden, Ont.

Edwin S. Flinn of the Mead Corp. has been transferred from Chillicothe, Ohio, to Lee, Mass., as Assistant to the President of the Hurlbut Paper Division.

Marshall S. Green, formerly of the Brown Co., is now an application engineer for the Black-Clawson Co., Watertown, N. Y.

William Hoge is now Director of Technical Specialties Development for Oxford Paper Co., Rumford, Me.

Harold Holden, formerly of Eastern Corp., is now President and General Manager of Gilman Paper Co., New York, N. Y.

Orren R. Hurd is now Assistant Manager of the International Paper Co., Chisholm, Me.

Carl C. Landegger is now Vice-President of the Black-Clawson Co., Watertown, N. Y.

Frank J. Lovegren is now Coordinator of Sales Services for P. H. Glatfelter Co., Spring Grove, Pa.

Wayne E. Kendrick, formerly of Allied Paper Corp., is now a project engineer for Gilbert Paper Co., Menasha, Wis.

Raymond R. Labbe, formerly student at the University of Maine, is now a field service engineer for F. C. Huyck & Sons, Greenville, Tenn.

Albert J. Marchand, Assistant to the Superintendent of Continental Can Co., has been transferred from Haverhill, Mass., to Natlick, Mass.

Bernhard K. Mayer is now Assistant Research Director for Oxford Paper Co., Rumford, Me.

William A. McKenzie, formerly of Simpson Timber Co., is now General Manager of Simpson Engineered Wood Products Co., Seattle, Wash.

David S. Most, formerly of Albermarle Paper Mfg. Co., is now Technical Service Superintendent for the Halifax Paper Co., Roanoke Rapids, N. C.

Rene Oehler, formerly of American Can Co., is now a research chemist for Riegel Paper Corp., Milford, N. J.

Lawrence B. Owen, formerly of W. R. Grace & Co., is now Vice-President in Charge of Manufacturing of the Paper Mill Division of Allied Paper Corp., Kalamazoo, Mich.

John R. Parkinson, formerly of Weyerhaeuser Timber Co., is now Technical Superintendent of Cascade Kraft Corp., Wallula, Wash.

John H. Payne, formerly of American Sugar Refining Co., is now a packaging engineer for Hudson Pulp & Paper Co., New York, N. Y.

Henry P. Petzold is now Assistant to the Vice-President of Oxford Paper Co., Rumford, Me.

George B. Redmond is now Manager of Industrial Sales for Clinton Corn Processing Co. Clinton, Iowa.

Charles W. Richards is now Manager of the International Paper Co., York Haven, Pa.

John B. Shields of Riegel Paper Corp. has been transferred from New York, N. Y., to Edinburg, Ind., as Manager of Midwestern Sales Development for Packaging Materials.

Thomas T. C. Shih, formerly of Taiwan Pulp & Paper Corp., is now with Shihlin Paper Co., Shihlin, Taipei, Taiwan, China.

James O. Sparks, Sulphate Foreman for Bowaters Southern Paper Co., has been transferred to Bowaters Carolina Corp., Catawba, S. C.

Joseph N. Swartz is now Technical Director of Bowaters Southern Paper Corp., Calhoun, Tenn.

John W. Tester, formerly of the U. S. Army, is now a trainee with the Container Corp. of America, Fernandina Beach, Fla.

Joseph C. Theiler is now Manager of Owens-Illinois Glass Co. Mill Division, Big Island, Va.

Jack F. Turner, Jr., is now Technical Director of the International Paper Co., Moss Point, Miss.

Robert F. Vokes is now General Manager of the Shartle Division of the Black-Clawson Co., Middletown, Ohio.

Howard P. Waldenmyer is now Assistant Pulp Mill Manager of the Oxford Paper Co., Rumford, Me.

Franklin O. Ware, formerly of Semet-Solvay Petrochemical Division is now a sales representative for Penick & Ford, Ltd. Inc., Cedar Rapids, Iowa.

Samuel T. Weber is now Vice-President of the Black-Clawson Co., Watertown, N. Y.

Charles J. Weidman is now Vice-President of the Ciba Co., New York, N. Y.

James D. Wethern, formerly of the Crown Zellerbach Corp. is now Technical Director of the Riegel Paper Corp., Acme N. C.

Industry Notes

PRODUCTION

Paper and board production in the United States during 1958, amounting to 30,797 thousand tons, was at the same level as in 1957 and only 2% below the all time peak recorded in 1956. Similarly, wood pulp production, at 21,734 thousand tons, remained at approximately the same level as in 1957. Comparable production figures for 1957 for paper and board and for wood pulp were 30,678 and 21,800 thousand tons, respectively.

Paper production totaled 13,525 thousand tons compared with the 1957 output of 13,593 thousand tons. Paperboard production in 1958 amounted to 14,151 thousand tons, as compared to 14,060 thousand tons in 1957. Production for 1958 of almost all major grades of paper and paperboard showed very small changes from 1957.

Paper and board production during December amounted to 2,506,705 tons. This was 9% above the 2,299,731 tons produced in December a year ago. Paper production amounted to 1,124,352 tons, which was 7% above the 1,051,-091 tons produced in December a year ago. The output of paperboard during this month was 1,139,683 tons, reflecting

an 11% increase above the production of 1,031,105 tons reported for December, 1957.

Pulpwood

Pulpwood receipts at the pulp mills in December amounted to 2,837,886 cords, with consumption at 2,820,749 cords. Month-end inventories decreased slightly to 5,929,929 cords.

Wastepaper

Consumption of fibrous materials other than pulpwood, totaled 774,924 tons in December, compared to 727,336 tons in December, 1957. Inventories of 937,177 tons at month's end reflected an 8% increase over end of November inventories. Consumption of wastepaper amounted to 691,016 tons, as compared to the 523,173 tons consumed in December a year ago.

Wood Pulps

While total production of wood pulp showed little change from the 1957 level, significant changes did occur in a number of the individual grades. Sizeable increases were shown for the bleached sulphate (7%), semibleached sulphate (12%), and defibrated or exploded grades (8%). A significant decrease (14%) occurred in the production of unbleached sulphite.

The consumption of wood pulp, including that consumed for other than paper and board manufacturing, was 22,505 thousand tons and consumption of fibrous materials other than wood pulp amounted to 9712 thousand tons. Pulpwood consumption amounted to 35,229 thousand cords, roughwood basis.

Wood pulp production during December amounted to 1,754,575 tons as compared to 1,616,517 tons produced in December a year ago.

Wood pulp consumption in the paper and board mills during December, amounted to 1,859,690 tons, compared to the 1,680,881 tons consumed in December a year ago.

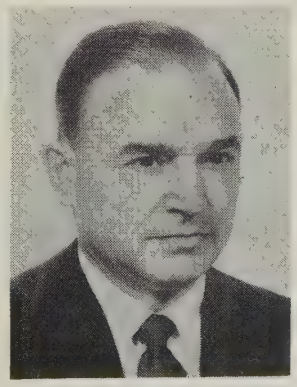
Wood pulp inventories at the end of December at the paper and board mills, amounted to 545,135 tons, as compared to 528,270 tons reported at the end of November. Month-end stocks of the pulp mills were 252,230 tons, as compared to 273,939 tons reported at the end of November.

Oxford

Oxford Paper Co. has announced important management changes in connection with its new kraft construction program and the operation of its Rumford mill.

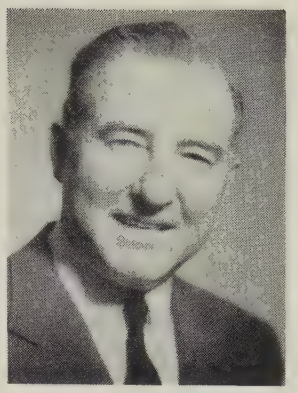
Henry P. Petzold is promoted to the position of assistant to vice-president Donald Appleton. In this new position Mr. Petzold will be located in Rumford, Me., and will coordinate the efforts of the various departments of the company involved in the design, construction and start-up of Oxford's new softwood kraft mill.

Mr. Petzold, a graduate of McGill University, joined Oxford in 1937 after previous experience with International Paper Co. He has held the positions of plant engineer, assistant mill manager and mill manager of the Oxford Miami Division and since 1955 has been mill manager of the Rumford, Maine operation.



H. P. Petzold, Oxford Paper Co.

Charles L. Ferguson is promoted to the position of mill manager of the Rumford Mill. Mr. Ferguson started work for the Oxford Paper Co. at an early age. In 1922 he became assistant superintendent of the soda mill, later he was promoted to superintendent of the soda mill, then assistant to the mill manager and in 1936, general superintendent of the Rumford mill. Since 1955 he has held the position of assistant mill manager, Rumford.



C. L. Ferguson, Oxford Paper Co.

W. H. Hoge, Oxford Paper Co.

The promotion of William Hoge to director of technical specialties development for the Oxford Paper Co. was announced February 16. As head of this important new department in Oxford, he will report to Harold M. Annis, vice-president—research and development. Mr. Hoge, a graduate of Ohio State University and The Institute of Paper Chemistry, has previously been a member of the Oxford Research organization. He was appointed Fundamental Research Group Leader in 1953 and Technical Specialties Group Leader in 1955.

Harold Buck has been promoted to Group Leader for technical specialties product engineering, under Mr. Hoge. Mr. Buck, a graduate of the University of Maine in Engineering Physics, was formerly assistant technical specialties group leader. He has been a member of the Oxford Research and Development staff since 1952.

Victor Mattson, a graduate of Union College and The Institute of Paper Chemistry, has been promoted to group leader for technical specialties research. Prior to his assignment to the new department, Mr. Mattson was fundamental research group leader, having joined Oxford's research organization in 1956, and was formerly with The Mead Corp. at Chillicothe, Ohio.

Harry B. Conner is promoted to the position of assistant mill manager—paper, at the Rumford mill with over-all responsibility for all paper manufacture, conversion, finishing, shipping and related activities.

Howard P. Waldenmyer is promoted to the position of assistant mill manager—pulp, at the Rumford mill with over-all responsibility for mill wood operations, pulping, bleaching, and related activities.

Bernhard Mayer of Rumford, Me., has been appointed assistant director of research, it was announced by Harold M. Annis, Oxford Paper Co. vice-president—research and development. Mr. Mayer, who is a graduate of the State College of Forestry at Syracuse University, joined the Oxford research department in 1950 and has been pulping group leader since 1953.

Colwyn Haskell has been promoted to Pulping Group Leader, succeeding Mr. Mayer. Mr. Haskell has a Master of Science degree in Chemical Engineering from the University of Maine. Mr. Haskell joined Oxford in 1955 and served in the technical service department prior to joining the research pulping group.

Knowlton

E. Way Clarke, who has been associated for nearly 45 years with Knowlton Brothers, specialty paper manufacturers of Watertown, N. Y., was elected a vice-president of the firm at the quarterly meeting of the board of directors.

Mr. Clarke has been production manager and purchasing agent of the company since 1941, and he will continue with

these functions in his new capacity as a vice-president. Mr. Clarke has always been associated with the manufacturing aspects of the company's business.

FINCH, PRUYN

Lyman A. Beeman, Jr., has been elected vice-president and merchandising manager of Finch, Pruyn & Co., Inc., Glens Falls, N. Y.

Formerly assistant to the president, Mr. Beeman was also re-elected a director of the company which is now in its 94th year.

Company officials re-elected to office at the annual director's meeting are: Lyman A. Beeman, Sr., president; Samuel Pruyn, vice-president; Elmer S. White, vice-president and treasurer, and Ernest W. Cronquist, secretary.

Finch, Pruyn & Co., Inc., Glens Falls, N. Y., is marshaling a full-scale merchandising program behind its new white Finch bond, the first bond paper made principally of neutral sulphite Northern hardwood pulp.

The merchandising and sales programs are based on several highly-promotable features offered by the new paper:

A "whiter" white bond at prices usually associated with more expensive bonds; greater strength and opacity and, because of its high-quality and low-cost advantage, the opportunity for users to upgrade their printing and still keep within reasonable cost limits.

Behind the announcement of this new paper, there's another story. Thanks to Finch, Pruyn research with nearby New York hardwoods, the economy of the entire Adirondacks area has been enriched by about $800,000 annually in wages, stumpage, and hauling costs. That's the amount the company paid independent farmers last year to harvest northern hardwoods on farm woodlots within a 50-mile radius of the mill at Glens Falls. Even though the company is probably the largest single landowner in New York, it has found it more practical to buy some of its hardwood pulp logs from private farmers near the mill than to harvest them from its own 168,000 acre holdings.

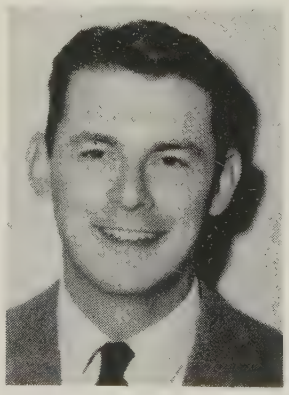
The hardwood fibers used in the new Finch bond and other papers in the company's line of book, printing, mimeo and office papers are converted to sulphite pulp in a $5,000,000 neutral sulphite mill built by the company in Glens Falls two years ago.

"We introduced this new Finch bond," said Lyman A. Beeman, Sr., president of the 94-year-old paper company, "because market conditions demanded a whiter bond paper than was available at conventional bond prices.

"In addition, we are situated in a part of the country rich in hardwood stands and it made a great deal of sense for us to try to make maximum utilization of the resources at our command.

"The introduction of this neutral sulphite bond paper will give us a complete line of papers for the business community. We can now help users upgrade the quality of their printed matter and still keep their costs within reasonable limits," he said.

E. W. Clark, Knowlton Bros.

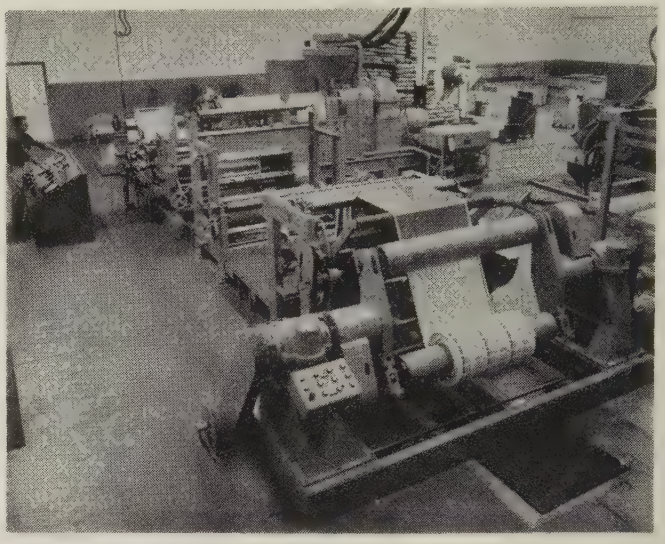


L. A. Beeman, Jr., Finch Pruyn & Co., Inc.

C-Z

Crown Zellerbach is currently installing the longest, widest, fastest paper machine of its kind in the country, at the new St. Francisville, La., mill. Measuring nearly 500 f . in length and 20½ ft. wide, the "Delta King" will produce double-coated papers at speeds formerly considered impossible. This specially designed giant is the first all new paper machine built to combine the advantages of roll-coating with the remarkable leveling action of the trailing-blade coater in one continuous, on-the-machine operation. The result is double-coated paper with a premium level/smooth surface at a nonpremium price. Crown Zellerbach expects to market these new papers this spring.

The Western-Waxide Division of Crown-Zellerbach Corp.,



Egan polyethylene coating machine

San Leandro, Calif., has installed a complete Egan polyethylene coating machine for the production of packaging papers.

The new high-speed unit was designed and constructed by Frank W. Egan & Co. of Somerville, N. J.

Equipped with Egan's latest flying transfer two-spindle turret winder with both constant and taper tension, as well as a turret unwind, the machine is capable of speeds up to 1000 f.p.m. It will handle lightweight papers, foil and cellophane and other films at web widths up to 54 in.

The 4½-in. extruder is mounted on a retractable carriage. The extruder hopper can be loaded from floor level with an IMS Dracco hopper loader.

Another special feature of the installation is that all wiring and piping have been concealed in floor trenches for maximum neatness and safety.

HAWTHORNE

Hawthorne Paper Co., Kalamazoo, Mich., announces that one of its wholly owned subsidiaries has purchased all of the paper mill properties in Hollywood, Fla. which were formerly owned by Pan American Paper Mills.

The property, located on the Seaboard Railroad, consists of more than nine acres of land, modern buildings approximately three years old, a 74-in. fourdrinier paper machine, complete beater room machinery, and finishing room equipment.

The present paper machine and stock preparation equipment will be converted to the manufacture of offset and writing papers, as well as 25% and 50% rag content papers.

Options have been obtained on two additional paper machines, one 142 in. and one 164 in. One of these will be added to this mill, making book and offset grades. Com-

pletely new, modern beater room equipment will be installed promptly, along with the necessary finishing equipment. A modern deinking plant will be built and equipped within the next 18 months. There is an excellent water supply for the manufacture of the paper grades planned.

It is felt that the strategic location of this mill, the natural export facilities, and the advantages of having raw materials such as pulp and cotton fibers available nearby, will enable Hawthorne and its subsidiaries to serve more efficiently all users of fine printing, writing and converting papers in the rapidly growing Southern market.

Weyerhaeuser

Radioactive isotopes, spectrophotometers, and controlled growth chambers are among the new tools being used by forestry researchers to help "keep the nation's wood basket filled," Weyerhaeuser Timber Co.'s annual forestry research report revealed March 5.

At its newly expanded forestry research center at Centralia, Wash., the company announced that 13 full-time forestry specialists are at work in the fields of silviculture, regeneration, management, physiology, soils, and protection from insects, disease, and wildlife damage. They are aided by statisticians, field assistants, and administrative personnel.

Behind the "Caution-Radiation" signs at the research center, the terrifying and destructive aspects of atomic energy are taking a back seat to more peaceful uses. Identifiable radioactive tracers are introduced into the complex system of trees to provide foresters with a clearer insight into the basic biological processes, the report said.

An experiment aimed at reducing damage to tree seedlings by rabbits, mice, and other rodents, uses isotopes in the development of repellents distasteful to these animals. Researchers hope to divert the rodents' eating habits to native vegetation.

According to the report, a big killer of ponderosa pine is dwarf mistletoe—a parasitic plant which drains the life from trees. Using photographs of beta- and gamma-particle radiation, called radioautographs, the foresters are testing the introduction of elements into the tree that are toxic to the dwarf mistletoe but not to the tree.

Other highlights of the year's forestry research work include:

Soil nutrient experiments were successful in boosting seed cone production five-fold and increased annual tree diameter growth 50%.

Experiments with repellents indicated that rodents' eating habits can be changed so that the 15,000 to 25,000 lb. of tree seed planted each year by the company survive the hungry mice to germinate and produce new trees.

To reduce natural mortality of trees due to the intense competition within a forest and to attain maximum use of all wood grown, thinning studies are showing increased growth and yield from treated areas.

Tests of new chemicals are continuing in efforts to find better selective herbicides which remove undesirable brush competing with young forest plantings.

Destructive girdling of immature trees by bears increased in 1958, the report stated. Aerial surveys show that over 200,000 acres on three of the company's 13 tree farms sustain considerable bear damage. Control methods are being adapted on company tree farms in cooperation with state game departments.

The impact of insect damage to Douglas-fir seed cones has curtailed reforestation programs during poor seed years such as 1958. Studies on control of the cone and seed insects involved testing ten insecticides for application on cone production areas.

A multimillion dollar bill for damages has been run up by the balsam woolly aphid in its attacks on approximately half billion feet of timber in the Pacific Northwest. Canadian and United States federal forest entomologists have imported natural enemies of the dangerous aphid. Weyerhaeuser research foresters aided in the colonization of these predators in infested stands of timber.

W. H. Cummings, Weyerhaeuser forestry research supervisor, says that the team of specially trained foresters who have the peaceful uses of atomic energy and other such valuable tools at their command, will grow higher quality forest products at a faster rate for use both today and tomorrow.

West Virginia

The Emerson Manufacturing Co., Division of John W. Bolton & Sons, Inc., Lawrence, Mass. has been awarded the contract to build stock preparation systems for the two new paper machines being built for the Luke, Md. mill of West Virginia Pulp & Paper Co. Contract calls for Emerson Claflins, jordans, automatic controls, and magnetic separators.

The two new paper machines are being built by Beloit and will include 22 Emerson continuous spray, stainless steel shower pipes.

Charles T. Main Co., of Boston, are the consulting engineers for the new installation. Start-up is scheduled for mid-1960.

Simpson

Expansion of Simpson Timber Co. into additional wood products was announced with the appointment of William A. McKenzie of Seattle as general manager of a new unit to be called Simpson Engineered Wood Products Co.

The new company becomes a fourth operating division of the pioneer Simpson firm, founded at Shelton, Wash. in 1895 and now operating 21 wood products plants in 12 communities of Washington, Oregon, and California.

C. H. Bacon, Jr., executive vice-president, said Simpson Engineered Wood Products Co. has been organized to design and sell products in whatever shape or form wood can be processed for customer needs.

"Simpson Engineered Wood Products Co. will be both versatile and flexible," Mr. Bacon said. "It is being organized to operate both in present Simpson locations and elsewhere. In some instances we may contract with other manufacturers to produce items for our customers."

National Tank and Pipe Co. of Portland, a Simpson Logging Co. operation since 1956, henceforth will be a part of Simpson Engineered Wood Products Co. Its facilities, under management of Charles Farmer, will be expanded into other products besides wood tanks and wood pipe.

Allied

L. B. Owen, with 27 years of experience in the pulp and paper-making industry will join the Allied Paper Corp. as vice-president in charge of manufacturing for the Paper Mill Division in Kalamazoo, Mich.

According to the announcement of Ward D. Harrison, president of Allied, Mr. Owen, who is now in Lima, Peru, will start his new duties soon after the middle of March.

For the past five years, Mr. Owen, considered a specialist in the production of fine papers, has been active in the paper industry of South America.

Before going to South America, Mr. Owen worked at various mills in this country. Before leaving for Montevideo, he acted as general superintendent of the P. H. Glatfelter Co., Spring Grove, Pa.

Glatfelter

P. H. Glatfelter Co. announced the advancement of three employees to help strengthen its sales service and quality control departments effective Feb. 1, 1959.

Frank J. Lovegren, a resident of Spring Grove, Pa., assumed new duties as coordinator of sales service dealing with problems of sales, manufacturing, and technical service.

Mr. Lovegren started with the company as an assistant supervisor in the new products department. Later, he assumed the duties of senior chemist and group leader in the technical department. Prior to his new appointment, he was supervisor of paper quality control.

He is an active member of TAPPI and has served as past-president of the Delaware Valley Section of TAPPI. He also has served on various committees and functions of the American Chemical Society.

Oliv V. Hyde, formerly assistant to the paper quality control supervisor, will now serve as the supervisor of this department.

He is a graduate of the College of Forestry in Syracuse, New York, having majored in pulp and paper technology. Mr. Hyde is an active member of TAPPI and served three and one-half years in the United States Navy being honorably dishcarged with the rank of Lieutenant j.g.

Wilson Kern, of Spring Grove, joined the industrial engineering department, where he will work on special assignments.

He joined the paper company in 1945 starting his career in the wood yard department, and advanced through the ranks to night superintendent. Prior to his new assignment, Mr. Kern was superintendent of Glatfelter's new no. 7 paper machine.

Mr. Kern has been active in the Pulp and Paper Association, the Society for the Advancement of Management and the York Foremen's Club. He served three years overseas in the United States Army as a chief warrant officer.

Riegel

A. L. M. Bixler, manager of manufacturing services for Riegel Paper Corp., Carolina Division, has announced the appointment of J. D. Wethern to the position of technical director of the Carolina Division. Mr. Wethern is a graduate of the University of Wisconisn and the Institute of Paper Chemistry. He was formerly coordinator of research and development for the Crown Zellerbach Corp., at Camas, Wash.

A. P. Mitchell, senior vice-president—sales, of Riegel Paper Corp. has announced a number of new appointments in the company's packaging materials sales organization of which Charles E. Schaehrer is manager. N. W. Postweiler has been appointed to the newly created position of special accounts manager; William M. Riegel, formerly product manager, has been promoted to the position of Eastern regional packaging sales manager. Wilson W. Cross succeeds Mr. Riegel as product manager of packaging materials.

John B. Shields has been promoted from product development engineer to Midwestern sales development manager for packaging materials, and will make his headquarters at the company's Edinburg Ind. plant.

International

The gas cleaning division of Hagan Chemicals & Controls, Inc., Pittsburgh, Pa. has received an order for two 960-tube aerostatic dust collectors from International Paper Co.

The two units—largest ever built by Hagan—will be installed this spring on two giant combination-fired Babcock & Wilcox cyclone boilers at International's paper mill in Mobile, Ala.

Rated at 750,000 lb. per hr. of steam, each boiler can be fired with crushed coal, bark, or lignite. Each of these collectors will clean flue gas at the rate of 250,000 cu. ft. per min.

Charles W. Richards has been named manager of International Paper Co.'s mill at York Haven, Pa., it was announced today by Stuart E. Kay, vice-president.

Mr. Richards succeeds the late Ralph Masten who had served for 18 years as mill manager until his death on Jan. 27, 1959.

Mr. Richards is a native of Needham, Mass., and graduated from the Massachusetts Institute of Technology in 1921 with a degree in chemical engineering. He joined International Paper Co. in 1928 as chief chemist at the company's mill in Rumford, Me. Several years later, coincident with the curtailment of operations at the Rumford mill, Mr. Richards joined the Oxford Paper Co. as chief chemist at their mill in Rumford.

He served with the Oxford Paper Co., except during a two-year period when he was named to the technical sales staff of the DuPont Co., until 1946 when he rejoined International Paper Co. as assistant manager at its York Haven mill. He has held this position until his present appointment.

James E. Carpenter has been named assistant manager of the Ticonderoga, N. Y., mill, of International Paper Co., it has been announced by George H. Rand, Northern Division manager.

Mr. Carpenter, who is a native of Ticonderoga, N. Y., and graduated from Ticonderoga High School, joined International Paper Co. in 1941 as a paper tester at the Ticonderoga mill. Following two years of service in the United States Army Air Corps, he returned to the Ticonderoga mill and in 1949, was named a machine tender. Three years later, he was appointed foreman of paper machines and in 1956 was named assistant general superintendent of the mill.

Brown

Appointment of Alvin P. De Sisto as plant engineer, Paper Division, was announced today by George Craig, chief engineer of Brown Co., northern New Hampshire manufacturer of pulp, paper, and other forest products. Brown's Paper Division includes both the Cascade and Riverside mills with a total of seven paper machines, as well as the large towel converting department where Nibroc twoels and wipers for various purposes are made.

Mr. De Sisto, a graduate of Northeastern University's mechanical engineering school in 1951, has broad experience in Brown's operations, having served in the central engineering department, wood handling department, and in the company's Bermico mill as its plant engineer.

During World War II, Mr. De Sisto served as gunner in the Eighth Air Force based in England. He is married, has five children and makes his home in Berlin.

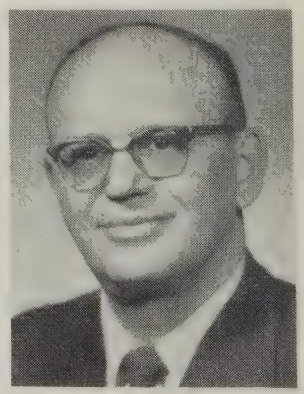
Tennessee River

Elmer Leavitt, manager of the Plymouth, N. C. plant of the Kieckhefer Division of Weyerhaueser Timber Co., has been appointed resident manager of the kraft pulp and board mill to be built by the Tennessee River Pulp & Paper Co. at Counce, Tenn.

Bowaters Southern

Promotion of Joseph N. Swartz to technical director of Bowaters Southern Paper Corp., of Calhoun, Tenn., has been announced by company officials.

In his new position, Mr. Swartz will continue to head the technical department of the mill at Calhoun and will also act as technical advisor to the general manager of Bowaters Carolina Corp. In addition, he will be responsible for research projects being conducted at the mills or at research centers for the companies, directing his attention primarily to quality improvement and process development.



J. N. Swartz, Bowaters Southern Paper Co.

Buckeye

Stricter control of pulp processing and better laboratory evaluation of bleaching agents have been made possible by Buckeye Cellulose research on the mechanism of the hypochlorite reaction in sulphate pine bleaching, according to Jack C. Paulson of Buckeye's research and development laboratories.

The end result of these research findings will benefit firms in the rayon, acetate, cellophane, and tire cord fields, the major users of sulphate pine pulp, according to Mr. Paulson.

In a paper delivered at the 44th Annual Meeting of the Technical Association of the Pulp and Paper Industry, Mr. Paulson stated that Buckeye's research has yielded new knowledge of the different phases of the hypochlorite reaction that makes possible more exacting control of the bleaching process. In addition, he said, better knowledge of rates and selectivity of attack now permits more thorough evaluation of bleaching agents.

Faster, safer, more accurate estimation of tall oil in kraft black liquor will be possible under a new analytical method developed by Kenneth A. Kuiken and William Saltsman of Buckeye Cellulose Corp. it was reported here today.

A unique solvent system which permits the easy separation of tall oil from lignin is the principal feature of the new Buckeye method, according to Dr. Kuiken. Specifically, he pointed out, definitive estimates of tall oil are obtained, laboratory time is cut about 50%, and the hazard of using volatile solvents at high temperatures is avoided under the new method.

Details of the new method for appraisal of tall oil recovery in kraft pulp production were revealed by Mr. Kuiken at the 44th TAPPI Annual Meeting.

A method for the direct colorimetric estimation of xylose in dissolving wood pulps that is faster and more accurate than furfural recovery techniques has been developed at Buckeye Cellulose, according to Kenneth A. Kuiken and Arthur F. Johnson of Buckeye's research laboratories.

The chief advantage of the new method, Dr. Kuiken reported at the 44th TAPPI Annual Meeting, is that it eliminates the necessity for initial hydrolysis of the wood pulp required in standard chromatographic techniques. With the Buckeye method, color is quickly produced by reaction of the wood pulp in an acid medium of anthrone, eliminating lengthy hydrolysis and consequent qualitative and quantitative uncertainties.

Diamond Gardner

Robert G. Fairburn, president of Diamond Gardner Corp., has announced that contracts had been signed for the purchase of all of the shares of stock of Hoosier Containers, Inc. and New Castle Realty Corp., New Castle, Ind. in exchange for 43,594 shares of Diamond Gardner common stock. The New Castle Realty Corp. owns Hoosier's and and buildings.

Mr. Fairburn said it was planned to merge Gardner Container, a Diamond Gardner subsidiary with plants in Dayton and Akron, Ohio, into Hoosier. Both are producers of corrugated paper products. Hoosier's name will be changed to Diamond Hoosier Containers, Inc.

Hoosier Containers was founded in 1954 and since that time has doubled its sales each year. In the 1958 calendar year its sales were about $3,000,000.

At its New Castle plant, Hoosier has a 76-in. corrugator and manufactures both corrugated sheets and containers. It employs 175 people in the office and plant.

Gardner Container has about 36 employes at its Dayton plant and 14 at Akron. 1958 sales were about $1,500,000.

Fome-Cor

The St. Regis Paper Co. and Monsanto Chemical Co. have announced the formation of the Fome-Cor Corp., a jointly owned company which will manufacture and market Fome-Cor, a unique foamed plastic and paper "sandwich" material.

W. R. Adams of New York, president of St. Regis, and Charles Allen Thomas of St. Louis, president of Monsanto, said that the new company will assume full control immediately of operations resulting from the joint technological and commerical development program that has been under way since early in 1956.

Mr. Adams said that investment in the Fome-Cor Corp. is another step in the St. Regis program to develop new materials and markets in the paper and container fields.

Monsanto's investment is part of a broad program to develop new applications for plastics, particularly in combination with other materials, Mr. Thomas said.

Temporary headquarters for the new company will be located at Springfield, Mass., which is headquarters of Monsanto's Plastics Division.

Fome-Cor consists of foamed plastic and paper laminated by a continuous process into a new and versatile material which retains high compression strength under severe moisture conditions, provides good insulation and cushioning properties, and is light in weight. It is capable of a broad range of uses for containers, displays, stage settings and many other applications.

Fome-Cor now is being manufactured in three forms or grades on semicommerical scale at the Superior Paper Products Co. plant of St. Regis Paper Co. at Mt. Wolf, Pa. The technology acquired as a result of this operation is being incorporated in the design and construction of a new and larger manufacturing unit at Addyston, Ohio, which will be operated by the Fome-Cor Corp. along with the Mt. Wolf installation. This additional facility is expected to be in operation early in 1959.

The election of Harry H. Balthaser of Longmeadow, Mass., as president of the Fome-Cor Corp. was announced February 11 after the initial meeting here of the new firm's board of directors.

Directors of the Fome-Cor Corp., besides Mr. Balthaser, are Reginald L. Vayo and Gardiner Lane of New York; J. Russell Wilson of St. Louis; and R. K. Mueller of Springfield, Mass.

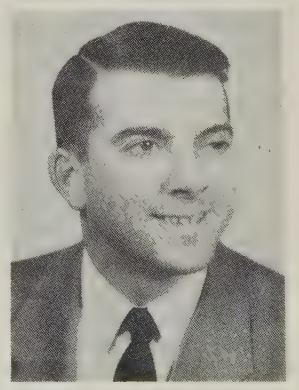
Other officers elected were Harold F. Stevens of New York, comptroller of St. Regis since 1956, who will be treasurer, and A. E. Bemarkt, business systems design coordinator for Monsanto's Plastics Division, who will be assistant treasurer; Harrison F. Lyman Jr., a member of Monsanto's law department since 1958, will be secretary.

Owens-Illinois

Joseph C. Theiler has been named manager of the Big Island, Va., mill of Owens-Illinois Glass Co., it has been announced by F. B. Schelhorn, mill division vice-president and manager of manufacturing.

He succeeds James W. Haley, who has been promoted to general manager of woodlands for the company with headquarters in Jacksonville, Fla.

James W. Haley has been named general manager of woodlands for the Owens-Illinois Glass Co.'s Mill Division in an announcement by C. G. McLaren, Owens-Illinois vice-president and general manager of the division.



J. C. Theiler, Owens-Illinois Glass Co.

Mr. Haley will assume responsibility for the direction of all woodlands functions which have been handled personally by Mr. McLaren. For the past two years Mr. Haley has been manager of O-I's Big Island, Va., mill.

A native of Tower, Minn., Mr. Haley began at an early age in the lumber and forestry fields, working for his father's timber company. After 12 years as manager of the Minnesota Box and Lumber Co., he became manager of the National Container Timber Corp. in 1950.

Mr. Haley later managed the Bedford Timber and Land Corp., a subsidiary of National Container Corp., of Virginia, prior to moving to Big Island in 1955 as assistant mill manager. He was named mill manager in 1956.

Mr. Haley will have his headquarters in Jacksonville, Fla. His staff will include George Abel, technical director of forestry, who transferred from the company's woodlands department in Toledo, Ohio, and Charles Nielsen, from the woodlands department at Big Island.

Simplex

The widest extrusion coater ever made is located at Simplex Paper Corp.'s Crossett, Ark. plant, it was announced.

Manufactured by Frank W. Egan & Co. of Somerville, N. J., the new unit provides Simplex with a highly versatile line capable of employing extrusion coaters in combination with reverse roll coaters and reinforcing materials.

The Egan extruder features case bronze heaters manufactured by Thermel Inc., Chicago, Ill. and is equipped with a 6-in extruder of 24:1 length to diameter ratio. It will produce 124-in. wide polyethylene coated paper. This is the only existing 24:1 ratio unit built for the paper coating industry.

Originally, the Simplex plant was equipped with two Egan reverse roll coaters, which, in addition to applying asphalt to the web, also carry reinforcing materials. With the addition of the Egan extruder, it now produces a complete line of waterproofed and reinforced papers.

Banner Fibreboard

Banner Fibreboard Co. has completed installation of a new 33,000 lb. Babcock & Wilcox boiler according to D. E. Lewis, vice-president and general manager. This installation will allow better control of processing in the production of Banner's colored linerboard and other paper specialties for corrugated box makers.

Fiber Products Research Center

William S. Wagner, formerly senior research chemist with the Chemstrand Corp., has been appointed manager of organic research of the Fiber Products Research Center, Inc., located in Beaver Falls, N. Y.

Wisconsin U.

An expanded program of graduate study in the field of forest products, providing paid research fellowships and assistantships to candidates for master of science and Ph.D. degrees, will be offered at the University of Wisconsin, Madison, Wis. during the academic year starting in September.

Several research posts will be available to applicants, according to an announcement from the graduate school of the university. Those receiving appointments will do research at the United States Forest Products Laboratory, maintained here by the Forest Service, United States Department of Agriculture, in cooperation with the university.

Appointees will be paid up to $2000 for the academic year, and there will be opportunities for summer employment at the laboratory, according to J. A. Hall, director.

Assistantships will be available in the fields of civil, mechanical, and chemical engineering, chemistry, biochemistry, botany, and plant pathology. The program is administered by a joint committee representing the university faculty and the Forest Products Laboratory staff.

Chairman of this committee is W. K. Neill, professor of chemical engineering. Other members are Professors R. A. Alberty, chemistry, L. W. Crandall, civil engineering, E. H. Newcomb, botany, and J. E. Kuntz, plant pathology; Director Hall; Ralph Lindgren, chief, division of pathology and wood preservation; J. A. Liska, chief, division of physics and engineering; and E. G. Locke, chief, division of wood chemistry, Forest Products Laboratory.

Candidates for the assistantships can obtain further information and enrollment blanks from Professor Neill, 3218 Chemical Engineering Building, University of Wisconsin, or from Director Hall, Forest Products Laboratory.

Syracuse

Bengt G. Rånby has been appointed as the director of the Empire State Paper Research Institute (ESPRI) and as professor of pulp and paper technology at the State University College of Forestry at Syracuse University, Syracuse, N. Y., effective April 1, 1959, according to Hardy L. Shirley, dean of the college.

Mr. Rånby has been research specialist and group leader with the American Viscose Corp., at Marcus Hook, Pa.

N. C. State

Under what conditions will it pay to fertilize trees?

That is the basic question prompting a study now beginning at North Carolina State College. The study is being carried on jointly by the college's School of Forestry and its Experiment Station and Allied Chemical Corp.

Announcement of the research study was made today by Richard J. Preston, dean, School of Forestry, and R. L. Lovvorn, director of research, Agricultural Experiment Station, North Carolina State College.

Other questions the study will seek to answer are: (1) What is the minimum amount of nutrients a tree can have in its foliage without being limited in growth by "hunger?" (2) Is it possible to tell how much and what analysis fertilizer a tree needs by checking the nutrient level of soil and foliage? (3) Can you trigger a growth response by applying the fertilizer these tests indicate the tree needs?

Emphasis in the study will be on development of sound, scientific techniques of diagnosis.

The current study is on loblolly pine, one of the most important timber trees of the South and the nation. Sample trees have been selected from plantations on good sites, sites of medium quality, and very poor sites in the Piedmont and Coastal Plain Provinces of North Carolina.

Stem analyses are being made in each plantation to find the pattern of past growth in relation to age. From 50 trees on each site, foliage will be collected during the dormant season and analyzed for nutrient content, specifically, for nitrogen, phosphorous, potash, calcium, and magnesium.

Simultaneously, soil samples will be analyzed to determine the total and available levels in the soil on the different sites. The resulting data will be correlated with the growth rate of the trees in an attempt to determine what nutrient factors appear to have the greatest influence on the growth of loblolly pine.

Subsequently, sample trees will be fertilized with different amounts of nitrogen, phosphorous, and potash, with and without lime, to determine the response of loblolly pine to these elements on the different qualities of site.

The study is believed to be the first of its kind to attempt diagnosing of the nutrient requirements of loblolly pine in a comprehensive way. The field work is being conducted by Emmett Thompson, a graduate of Oklahoma A & M College, who is now studying for the Master of Science degree at the School of Forestry, North Carolina State College.

Project leader for the Study is T. E. Maki, head of the college's Department of Forest Management. Harvey J. Stan-

gel, chief agronomist of the Nitrogen Division, Allied Chemical Corp.; Ralph McCracken of the Soils Department, North Carolina State College; and David Mason of the Department of Experimental Statistics, are serving as advisers for the project.

Mr. Maki, one of the country's leading authorities on forest tree nutrition, views the study as a possible break-through from experimental plot to commercial tree growing.

"We have shown through numerous experiments," Mr. Maki said, "that fertilizer will increase tree growth. Now we hope to determine how this knowledge can be put to practical use, exactly when, where and how a commercial tree grower should use fertilizers to realize the highest possible profit from his forest land."

Washington U.

Construction of a pilot plant (a miniature model not for actual production) to test a process developed by University of Washington scientists, seeking to eliminate odorous components of gases from kraft pulp mills, will begin immediately at St. Regis Paper Co. Tacoma. Developed at the University's Pulp Mills Research Project, the process came out of scientific research conducted for the past 10 years. St. Regis was chosen because its nearness to the university will expedite supervision and scientific control by university researchers. The mill, a member of the Northwest Pulp and Paper Association which sponsors the research, will contribute construction and operation personnel. Findings will be made available to all NWPPA members. The work could take a year, although preliminary results may be available by spring. Although the university researchers are optimistic, they caution that many a laboratory-scale process did not result in success in either the pilot or full-scale plant.

The process, the scientists hope, will collect and concentrate gases from several sources, and will dispose of them by burning. University of Washington researchers first had to identify the gaseous components, an outstanding job of scientific detective work in itself. Processes and equipment necessary to accomplish the treatment were then designed.

During cooking of wood to form cellulose pulp (as with any cooking) gaseous by-products are given off. Presently kraft mills use all known and economically practical processes and equipment to reduce odors, but small noticeable quantities of gases remain. These have not been removable with present methods. The important steps in the University of Washington process which may be successful in almost complete removal are:

1. Processing black liquor (in stripping columns) to remove odorous compounds.
2. Concentrating them (in rectifying columns, to such an extent that they can be consumed in a furnace.

It is hoped that some by-products can be recovered and reused.

Permutit

Pfaudler Permutit Inc. announces the publication of their new Bulletin No. 4486 outlining the equipment for treating industrial wastes. This booklet highlights not only the equipment but the engineering services and the complete waste treatment systems offered by Pfaudler Permutit Inc. One of the features of this booklet is a description of the new Permutit Colloidair separator which can be used for reclaiming fibres from paper mill white water. For further information contact Charles G. Bueltman, manager, Industrial Wastes Division, The Permutit Co., So West 44th St., New York 36, N. Y.

I-T-E

A comprehensive new bulletin designed to aid in the selection of metal-enclosed bus for utility and industrial use has been published by the I-T-E Circuit Breaker Co., 1900 Hamilton St. Philadelphia 30, Pa.

The 20-page bulletin gives ratings and construction details of the company's complete line of isolated phase and nonsegregated phase bus and bus auxiliary equipment.

Ciba

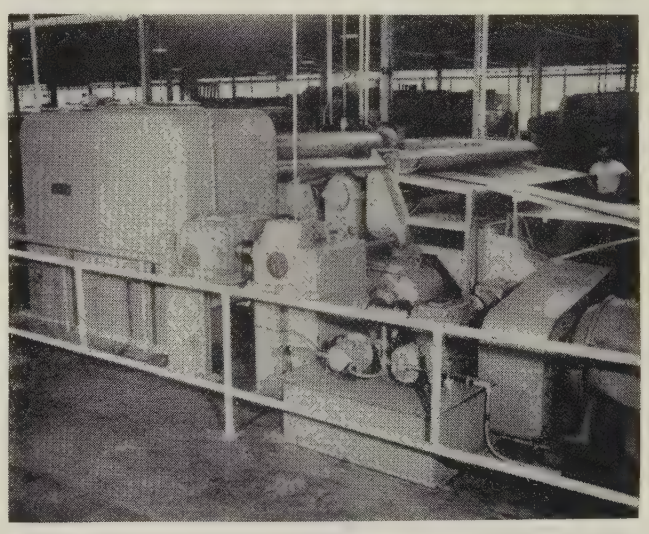
William H. Kieffer and Charles J. Weidmann have been elected vice-presidents of the CIBA Co. Inc., it was announced February 9 by Harry B. Marshall, president of the firm.

Koppers

A unique cut-off machine, which promises to save up to 3% in the production of corrugated board for boxes, has been developed by the F. X. Hooper Box Machinery department of Koppers Co., Inc., Glenarm, Md., it was announced February 5.

The machine cuts much faster and more efficiently than conventional cut-off machines and will result in savings to individual users of as much as $75,000 a year by drastically decreasing scrap loss and increasing total production time, the announcement said.

The machine has been under development by Koppers for the last five years. A prototype has been operating at Maxwell Bros. Inc., Chicago, Ill., since July, 1957 and has performed successfully in every respect, the company said. According to statistics compiled by Maxwell Bros., the machine saved $56,000 the first year through increased production and a decrease in scrap loss. Since Maxwell Bros., Chicago, is classified as a moderate speed plant, greater savings can be expected for plants operating at a faster rate of production.



Prototype unit of new cut-off knife machine developed by the F. X. Hooper box machinery department of Koppers Co., Inc., Glenarm, Md., is shown in operation at the Maxwell Bros., Inc. corrugated box plant in Chicago, Ill. The machine virtually eliminates the trimming of sheets of corrugated board and promises to save up to 3% in the cost of producing corrugated boxes

Dow

Frank J. MacRae has been named manager of plastics technical service for The Dow Chemical Co.

Reliance

A new bulletin, G-5812, describes the complete line of Reeves variable-speed drives which provide precise infinitely adjustable output speeds from a constant rpm. motor source operating from standard in-plant a.c. circuits. Individual copies of Bulletin G-5812 are available by writing to Reeves Pulley Co., Division of Reliance Electric and Engineering Co., Columbus, Ind.

A new Reliance a.c. motor selector booklet, Bulletin B-2103-4, gives concise selection data to users of a.c. motors from one through 200 hp. Free copies of Bulletin B-2103-4 may be obtained by writing to Reliance Electric and Engineering Co., 24701 Euclid Ave., Cleveland 17, Ohio.

Better customer plant operation through careful analysis of drive failures is the goal of the Renewal Parts and Repair Divis on at Reliance Electric and Engineering Co., Cleveland, one of the nation's leading manufacturers of electric motors and drive systems for industry.

The Renewal Parts and Repair Division, located in the company's modern 144,000-sq. ft. plant in suburban Euclid, Ohio, offers complete repair service for any piece of drive equipment ever built by the company, and for most comparable drive components of other manufacture.

The facility is geared to handle repairs on all Reliance a.c. and d.c. motors from one through 1000 hp. and all electric and electronic motor controls of the type manufactured by Reliance. In addition, the division provides complete winding repair and many parts for motors other than those made by Reliance.

As an integral part of the repair service, the division carefully checks the operating environment and load demands placed upon the motor being repaired, to determine the reason for its failure. Skilled engineers and motor repair specialists, working with the most modern equipment, analyze the application and compare it with the motor size and characteristics to see what element or group of elements was responsible for the motor breaking down. Once the cause is determined, steps for correction of it are recommended to the customer to prevent its recurrence.

Although apparently aimed at putting the repair group at Reliance out of business, the practice has already put the company well ahead of last year's pace, which resulted in bookings in excess of $9,000,000.

Monsanto

Monsanto Chemical Co. has begun construction in Nitro, W. Va. of a new plant for the manufacture of Mersize, a chemically fortified pale rosin size used by paper manufacturers to give water resistance to paper and paperboard.

It is the second new plant for this product to be announced under construction by Monsanto within the past month. A similar unit is being built by the company at Seattle, Wash., to service the Northwest's rapidly growing paper industry.

The combined capacity of the two new plants will be a major increase in the company's production capacity for Mersize. It is now produced at Baxley, Ga., and Montreal, Canada.

Monsanto Chemical Co.'s Inorganic Chemicals Division has announced the publication of a revised technical bulletin on the use of sodium sulphite, anhydrous technical (Monsanto's Santosite), for removing oxygen from boiler feed water. Copies are available free from Inorganic Chemicals Division, Monsanto Chemical Co., 800 North Lindbergh Blvd., St. Louis 66, Mo.

Monsanto Chemical Co.'s Plastics Division has announced that the production capacity of its high pressure polyethylene plastics facilities in Texas City, Texas will be increased to 100,000,000 lb. a year.

H. K. Eckert, assistant general manager of the division, said that construction work on the capacity increase has begun here and that the project is scheduled for completion in the third quarter of this year.

Eckert said that this expansion will speed the commercialization of several significant high-pressure technical advances.

Arnold, Hoffman

The Northern sales office of Arnold, Hoffman and Co. Inc., manufacturers of organic chemicals, is now located at the company's home office building, 55 Canal Street, Providence, R. I. Arthur C. Merrill, long experienced in other departments of Arnold, Hoffman, has assumed the post of office manager for the Northern sales operation. All orders, correspondence, inquiries, and other matters pertaining to Northern sales should be directed to the Providence address, Arnold, Hoffman states, and New England customers should use the Providence telephone service at GAspee 1-2935. A private Paterson, N. J. telephone connection—ARmory 8-1223—will be available to customers outside the New England area.

For the convenience of customers heretofore serviced from Arnold, Hoffman's New Jersey warehouse, Ahco will maintain warehouse stocks at Desmond's Warehouse, 824 Twenty-first Ave., Paterson, N. J.

Borden's

Manufacture of four new Protovac cold-water soluble caseins, PV-424, PV-428, PV-430, and PV-800, has been announced by the Borden Chemical Co.

Unlike most conventional caseins, which, after soaking and the addition of alkali, require up to 60 min. of heating at from 130 to 180°F., the new Borden products require only 10 min. of alkali soaking and about 30 min. of mixing at only 60 to 80°F. The rate of solution can be increased by use of a high-speed mixer, such as the Cowles Dissolver. High-speed mixing presents no foaming problems, Borden's reports. Use of the products eliminates the need for cooking equipment.

Additional information may be obtained from the Borden Chemical Co., Casein Department, 350 Madison Ave., New York 17, N. Y.

Appleton Machine

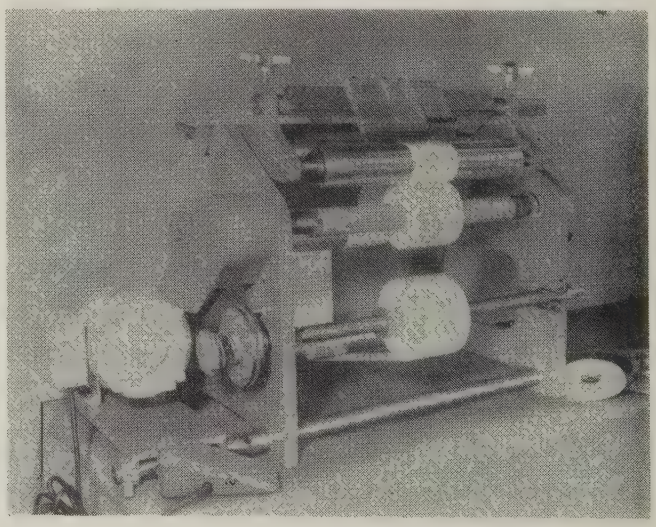
The Appleton Machine Co., Appleton, Wis., has announced the promotion of three executives. They are Victor W. Bloomer, chairman of the board; Tany Agronin, president; John M. MacDonald, Jr., vice-president. The appointments were made during the firm's annual meeting of its board of directors and became effective the first of the year.

Mr. Bloomer, who began with Appleton Machine in 1920, has served as its president since 1949 when he replaced the late H. P. Madsen.

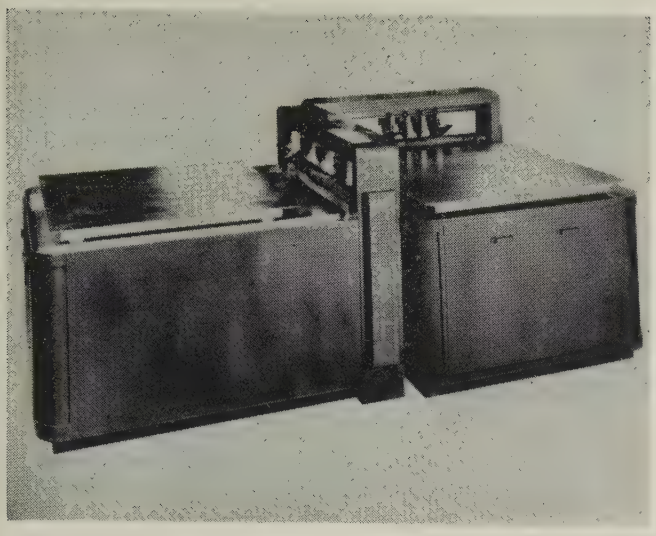
Mr. Agronin, previously executive vice-president and general manager, joined the firm last year. Before that he was manager of Black-Clawson Co.'s Brazilian affiliate, Companhia Federal de Fundicao.

A new bench slitter capable of slitting extremely thin material into narrow widths is now on the market

Appleton Machine Co. BSR-18 bench model slitter is used on paper, synthetics, and tissue. It's primarily intended for slitting small parent rolls—on short-run operations requiring a minimum of set-up time—into narrow widths.



Appleton Machine BSR-18 slitter



Appleton Machine cross cut slitter

The BSR-18 is designed for slitting vinyl plastics or coated unsupported fabrics up to 40 gage. Teflon, coated fabrics, polyethylene, leatherette, coated paper and condenser tissue as thin as 0.00025 in. can also be slit on this machine.

The slit material is rewound on a single rewind shaft without interleaving or fusing (narrow widths could not support themselves if rewound on a duplex principle). The bench slitter rewinds the material on rolls one next to the other across the entire face of the web during the complete operation. For additional information write: Appleton Machine Co., Doven Division, Appleton, Wis.

The Jerome Kinoy Co., 360 S. Broadway, Yonkers, N. Y., has been appointed manufacturers representative by the Appleton Machine Co., makers of pulp and paper mill and packaging equipment.

The Kinoy firm will represent Appleton in metropolitan New York and Long Island. Kinoy will handle Gilbert and Nash air guides, filled rolls, and products of the Appleton, Wis., firm's Doven Division.

A new idea in skin packaging perforation and separation has been developed by Appleton Machine Co., with its introduction of a new type cross cut slitter.

The new cross cut slitter is actually two identical machines set at right angles to each other. The first operation is to perforate or notch the aisles of large sheets of blister or skin packages. Next the sheets are slit completely through at right angles to the first line of cutting. The result is individual packages each containing its own product.

Blister or skin packages are vacuum formed from translucent plastic materials enclosing such items as hadeware, toys, or sporting goods on a printed card. Other materials suitable for slitting on the new cross cut machine include supported fabrics, rubber coated fabrics, rigid polyethylene, and hard fabrics.

Main features of the cross cut slitter are automatic feed, self-contained scrap bin for deflected trim, air manifold with pressure regulator, and variable speed motor drive.

For additional information write: Appleton Machine Co., Doven Division, Appleton, Wis.

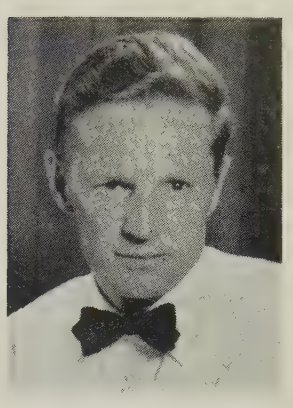
Infilco

Infilco Inc. of Tucson, Ariz. announces the publication of a new 16-page bulletin on volumetric extrusion type dry chemical feeders. Bulletin 215 discusses the construction and operation of the company's E feeders.

Krofta

Krofta Engineering Corp., Lenox, Mass., has announced the appointment of Albert O. Dyson as sales manager.

A. O. Dyson, Krofta Engineering Corp.



N. F. Putnam, Improved Machinery Inc.

In announcing Mr. Dyson's addition to the company, John McWilliams, vice-president and general manager, pointed to the increased service Krofta now has available for the paper industry in the field of clarification of mill effluent and the control of stock consistency to the paper machine.

Impco

Improved Machinery Inc., Nashua, N. H. has announced the election of Neil F. Putnam as vice-president—engineering. Mr. Putnam, who has been manager of engineering since 1956, became associated with Impco in 1935 as a draftsman.

Eaton Mfg.

Directors of Eaton Manufacturing Co. and Cleveland Worm & Gear Co. at separate meetings recently approved a transaction whereby Eaton will acquire the assets and business of Cleveland Worm & Gear and its wholly-owned subsidiary, the Farval Corp.

An announcement by John C. Virden, chairman and president of Eaton, and Howard Dingle, chairman of Cleveland Worm & Gear, said that following approval by shareholders of the latter company, a total of 81,670 shares of Eaton's capital stock would be exchanged on a share for share basis for an equal number of Cleveland Worm & Gear shares currently outstanding.

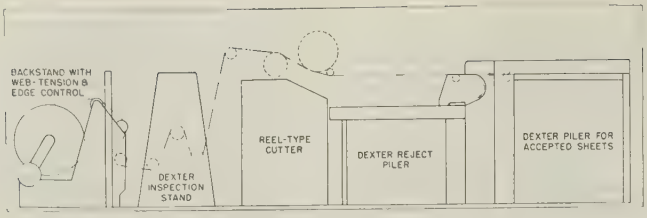
The executives stated that upon completion of the transaction, scheduled for Jan. 31, 1959, Cleveland Worm & Gear would be operated as a wholly-owned subsidiary of Eaton under the guidance of its present management and with no changes in personnel, products or sales policies.

Dexter

The Dexter Co. Division of Miehle-Goss-Dexter, Inc., Pearl River, N. Y., in cooperation with the S. D. Warren Co., Cumberland Mills, Maine and the Champion International Paper Co., Lawrence, Mass., has developed a new paper finishing machine which in one continuous operation inspects the web for lumps or voids, sheets it to size, stacks good sheets smoothly and evenly ready for packaging and shipping, and directs defective sheets into a reject pile.

The machine, the first of its kind, has been under development for some four years and is currently being evaluated in daily operation at the S. D. Warren Co. It includes an unwind stand with automatic tension control rolls, inspection station, reel-type cutter, and layboys for first quality paper and rejects. Roll sizes may range from 32 to 82 in. in width and to 42 in. in diameter. Web may be sheeted in lengths ranging from 36 to 80 in.

The unwind stand is a shaftless type and web unwinds from it through tension control rolls to the inspection stand. This stand has two inspection stations, one which inspects for lumps, wrinkles, welts, and the like, and the other which inspects for holes, tear outs, and other voids. The inspection



New Dexter finishing machine

devices sense flaws by contacting and "feeling" the surface of the moving web.

Should a defect be encountered, a memory device is signalled and when the imperfect sheet reaches a certain point on the tap bed, guide fingers raise from between the tapes and deflect the sheet to the reject pile. The machine can also be fitted with web markers to provide a visual indication of the location of the defects in the rejected sheets. The memory device is a magnetic tape type, engineered especially for the purpose by The de Florez Co., a design affiliate of The Dexter Co.

After leaving the inspection stand, the web travels to the cutter which sheets it to size and discharges the sheets onto tapes for delivery to one of the two Dexter layboys. The good sheet piler is located at the end of the tapes and the reject piler is under them. A counter indicates the number of good sheets as they are piled and marker tapes are automatically inserted every 25, 50, 100, 250, or 500 sheets, depending upon customer preference.

Sheets are cut within $^1/_{64}$ in. of nominal size, due principally to constant web-tension control at the unwind stand. An electronic side guide is used to keep the web travelling true and the machine is also equipped to trim web edges when this is desired. Trim is pneumatically conveyed to a waste cart.

Several steps have been taken to maintain sheets in perfect condition and to stack good sheets in such a manner that the compeleted pile is ready for shipping. Sheets travel 15 to 20 in. apart (are not overlapped) to permit one sheet partially to settle on the pile and be jogged before the next sheet arrives. Forwarding wheels which advance the sheet from tapes to pile automatically slow down as the last few inches of the sheet passes between them, thus retarding sheet speed (in excess of 400 f.p.m.) to prevent damage to the front edge upon hitting the piler stops. Timed air is blown onto the top of the sheet as it reaches the pile to hasten settling. Side joggers are drilled with holes countersunk on the pile side so that sharp oscillation of the joggers from the pile creates a fanning effect and quickens the exit of air from beneath the settling sheet. Since there is less concern for the appearance of the reject pile, the reject piler has simpler slow down and jogging devices.

At present, the finishing machine is operated with a single roll. However, two-roll operation can be provided. Two-roll operation will involve two unwind stands and two inspection stations but will employ the present cutter and layboys. This will more than double the capacity of the more expensive portions of the equipment and is well justified economically despite the fact that for each defective sheet, one good sheet will be rejected. The small amount of wasted good paper can well be afforded for the additional production achieved, or alternately the rejects can be resorted to relcaim the good paper.

The general goal in inspecting paper is to furnish the printer with stock which will not contain lumps or foreign matter which might cause type smash-ups, will not contain holes through which ink could pass and require downtime for press wash-up, and will not have turned corners or short sheets which would cause press trips. The finishing machine sensitivity setting in any given case will depend upon the standards for the particular grade of paper and upon mill requirements. More than sufficinet sensitivity is provided in the instruments to permit detection of defects smaller than those normally requiring removal.

Further information may be obtained from the Dexter Co., Pearl River, N. Y.

ADM

Archer-Daniels-Midland Co. has announced that it is producing amides, fatty nitrogen chemicals with many industrial uses, in commercial quantity.

ADM said that its Wyandotte, Mich. chemical plant is manufacturing coco, hydrogenated tallow, stearyl, erucyl, and oleyl amides from the fatty acids which the plant also produces.

The ADM amides, available through the company's development department, are the newest members of the company's expanding line of fatty nitrogen compounds. These products are marketed under the trade name Adogen.

Minneapolis-Honeywell

The new Honeywell Index of Literature is now available. This 24 page bulletin lists Industrial and Valve Division literature. *Product Catalogs* contain operating principles, instrument characteristics, application data, general specifications, and ordering information. *Specifications* provide detailed specifications on an instrument or series of instruments. *Technical Bulletins* deal with fundamental studies of instrumentation, and engineering aspects relating to application of an instrument to a specific process or industry. *Industry Bulletins* cover instrumentation as applied to an entire industry. *Systems Bulletins* describe instrumentation concerning a particular system *Instrumentation Data Sheets* report actual application of instruments on particular processes in specific industries.

A complete alphabetical subject-company index of *Instrumentation* magazine articles is included. In addition, Educational Aids and other Honeywell services and literature are described. Call or write for Bulletin G2-1a at any Honeywell branch office.

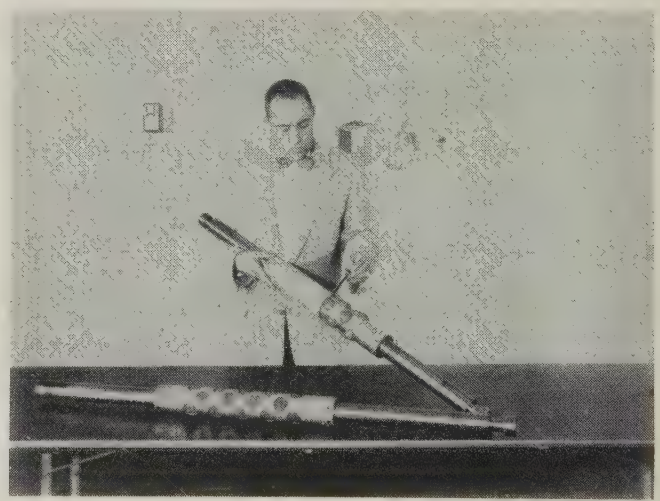
Allis-Chalmers

Construction and operating features of Vari-Pitch integral shaft sheaves for low-cost stepless speed control in large machine drives are given in a new bulletin released by Allis-Chalmers. Copies of the bulletin, 20B7897B, are available on request from Allis-Chalmers, Milwaukee 1, Wis.

B-C

A new and unique expanding shaft which quickly engages cores for winding and unwinding operations is being introduced by The Black-Clawson Co., Dilts Division, Fulton, N. Y.

Trade-marked Fairchild after its inventors, this expanding core shaft utilizes a heavy rubber tube secured to a hollow core shaft; capable of supporting heavy stock rolls. The



Fairchild expanding core shaft

rubber tube is encased in a perforated steel sleeve which is mounted to the core shaft. When expanded by air pressure, the rubber "bubbles" grip the core securely.

Antara

Antara Chemicals, Sales Division of General Aniline & Film Corp., New York has appointed Amsco Solvents & Chemicals Co., 4619 Reading Rd., Cincinnati 29, Ohio, as distributors for Igepal CO and CA surfactants. They will provide prompt truck delivery of drum and bulk quantities in Cincinnati, Dayton, Columbus, Springfield, and the Southern Ohio area.

M-G-D

In addition to the sales of the corporation's Miehle Co. division, D. O. Anderson, Miehle-Goss-Dexter, Inc., representative in northern Ohio, will now be responsible for the sale of paper-cutting and bindery equipment from The Lawson Co., also an M-G-D division. Mr. Anderson, makes his office at 3537 Lee Rd., Cleveland.

National Starch

"Behind the statistics that describe the expansion of the paper industry, is a creative revolution in research and development. Like all revolutions in industrial technology, this one has brought the laboratory and the production line closer together. In many paper plants, chemists and operating personnel who formerly did not know each other are now on a first name basis. This new alliance between the test tube and the mill is greatly responsible for the introduction of different and modified paper products into mass markets." These comments by Leonard J. Wood, technical manager of Paper Development and Service, National Starch Products Inc., opened the seventh annual conference of the company's Paper Sales and Development Group.

Mr. Wood pointed out that paper people can reflect with pride on the volume consumption of many products that a short time ago were laboratory phenomena. Some examples are lightweight machine-coated publication grades that insure excellent paper performance but have reduced postage rates; bleached packaging board, like those used to make flip-top cigarette containers; extensible papers; and functional coatings that incorporate plastic and greaseproof properties.

For the past 15 years National Starch Products has actively contributed to the creative revolution in paper. Historically the company has endeavored to intergrate the boldness of research with the realistic demands of plant production and market economy. The result has been a flow to the paper industry of vital techniques, ideas and heavy tonnage materials. National has broadened this program of plant-oriented research by increasing its personnel and facilities and expanding production. Today, more than ever, the company is committed to the betterment and continued progress of the paper industry.

Some of the products that National pioneered and now supplies to the paper industry are described by them below.

Cato 8. A cationic starch derivative that is a wet end additive. Improves Mullen, tensile, interply bondage, and pick of papers and boards. Excellent pigment and filler retention combined with superior filler-to-fiber and fiber-to-fiber bonding through electrochemical attraction, as well as natural adhesion, produce high ash content sheets without loss in strength. Cato 8 is used to raise the quality of various grades of paper, such as lightweight coated papers, kraft bag and liner stock, offset papers, and writing papers. This starch derivative also significantly improves the strength of tissue papers.

Kofilm. A family of acetylated starch derivatives for surface sizing and coatings applications. They possess high film and binder strength, flexibility, unique stability, and impart to paper and board superior surface characteristics. Improved operational characteritics and better quality control of the finished paper are attained. This grease and oil resistant starch derivative has been marketed for one year. In that time industrial acceptance has been so universal that Kofilm is now regarded as a generic type.

Kobond. A cold water swelling starch product designed specifically as a carrier for corrugating adhesives. No additional cooking is required. Exceptional water retention and viscosity stability permit reduction in the amount of adhesive applied; costs per thousand square feet of board have been lowered as much as 20%. Kobond withstands breakdown even under excessive shear and provides improved quality board at high production speeds.

Resyn 2203. A vinyl-acrylic copolymer used for functional paper coatings and standard pigmented coatings. Possesses outstanding film clarity and mechanical stability combined with first rate oil and water resistance. Particularly adaptable to size press coating. Because they are characterized by improved pigment bonding strength, smoothness, calenderability and varnish holdout, coating mixtures of Resyn 2203 and starch are replacing protein coatings on offset papers. Functional resin coatings were developed in a program initiated by National in cooperation with some particpating paper mills.

Resyn 3120. A new low-cost vinyl acetate copolymer latex designed for functional paper coatings as well as coated printing grades of paper. Resyn 3120 in initial field and mill tests has shown exciting promise for bread wrap, offset printing, label stock, and publication grade papers that presently use rubber latex as a supplemental binder. This vinyl acetate latex is preferred over the rubber latices because it produces better binding and water resistance and reduces excessive limpness.

Rohm & Haas

Rohm & Haas Co. announces the availability of its newly revised 16-page booklet, "Rhoplex Acrylic Emulsions in Paper Coatings." This booklet is available on request from Resinous Products Division, Rohm & Haas Co., Washington Square Philadelphia 5, Pa.

Midland-Ross

The Chicago Offices of the J. O. Ross Engineering Division, Midland-Ross Corp., have moved into the company's new suburban building at 370 South School St., Mt. Prospect, Ill. The Hartig Extruder Division, Midland-Ross Corp., and the John Waldron Corp., a subsidiary of Midland-Ross, has also moved their Chicago offices into the new building.

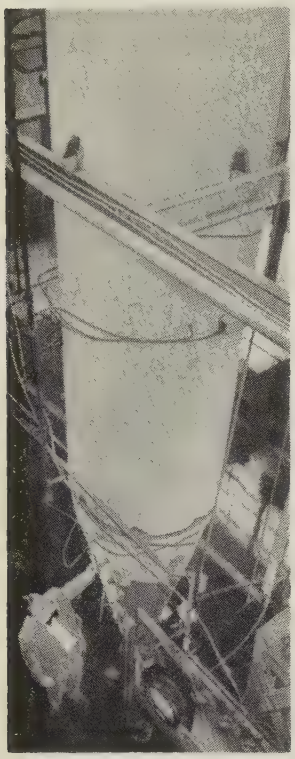
Located in Weber's Industrial Park, the modern air conditioned building has approximately 12,500 sq. ft. of floor space, about three times the area of the leased space vacated in the Loop, and the site provides for future building additions.

New Chicago office of the J. O. Ross Engineering Div., Midland-Ross Corp.

Engineers and executives of the J. O. Ross Engineering Division of the Midland-Ross Corp. met in the new Chicago office for two days in mid-February to discuss recent air-system developments, new Ross research activities, and such internal matters as sales promotion, recruiting and training, participation in trade association affairs, etc.

Some of the more detailed topics covered include calculations for paper mill air systems, drying clay coatings, calender cooling, Ross-Hooper hood and exhaust systems, Yankee air system, comfort ventilation, and special drying. Also discussed were foreign markets, patent protection, and ways to better serve the paper industry.

STALEY



Pibot unit for dextrinization process

A new dextrinization process patented by the A. E. Staley Manufacturing Co. promises cleaner, lighter-color, more uniform and specification-sure dextrins, Staley researchers report.

L. S. Roehm, vice-president heading the company's corn division, said that dextrin produced by the new process represents a big step forward to meet specialized requirements of a number of industrial users.

The new process "fluidizes" dry powdered starch by air flow to permit an extremely even distribution of heat and acid to each particle of starch for conversion to dextrin.

The conversion is much more uniform than with conventional batch dextrinization, according to Ralph E. C. Fredrickson, Staley's director of engineering research and inventor of the new process.

U.S.I.

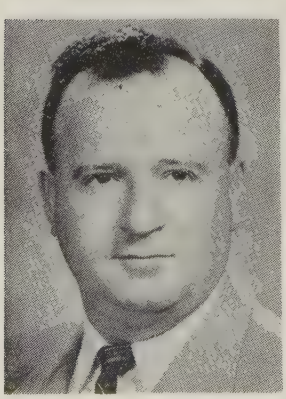
The appointment of Richard C. Phelps as customer service group leader for U. S. Industrial Chemicals Co., has just been announced. In his new position, Mr. Phelps will supervise technical service to customers for Petrothene polyethylene resins.

PATTON

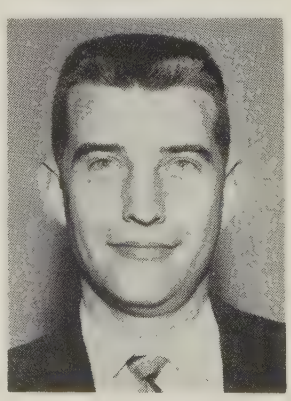
Patton Manufacturing Co. of Springfield, Ohio, will represent two German paper machinery building companies as exclusive sales agent in this country, according to an announcement made by George S. Herbert, president of Patton Manufacturing Co. The two German firms to be represented by Patton in the United States are: Bruderhaus Maschinenfabrik of Reutlingen, Germany, and Strecker-Bruderhaus Co. of Darmstadt-Eberstadt, also Germany.

Patton will act as exclusive sales agent for the Bruderhaus winder, rewinder, and suction roll lines and for Strecker-Bruderhaus, Patton will handle rotary cutters, automatic pulp baling equipment, and refiners. In addition to handling sales of this equipment, Patton will also perform erection services for mills and converters in this country. In addition, Patton will stock all spare parts for this equipment, according to Mr. Herbert.

The appointment of Frank Scribner as project engineer with Patton Manufacturing Co., paper mill machinery builders of Springfield, Ohio, has been announced by George S. Herbert, president of Patton.



R. C. Phelps, U. S. Industrial Chemicals Co.



Frank Scribner, Patton Manufacturing Co.

THWING-ALBERT

The new Thwing-Albert fotosize penetration tester, based on an instrument designed by Hercules Powder Co., determines the sizing of a paper sample by the objective photoelectric measurement of light reflectance from the sample during penetration by a test liquid. The instrument provides an accurate means of determining the time required for the test liquid to penetrate to the point where reflectance of the paper surface is reduced to a definite and predetermined percentage of its original value.

Hercules ink penetration tester manufactured by the Thwing-Albert Instrument Co.

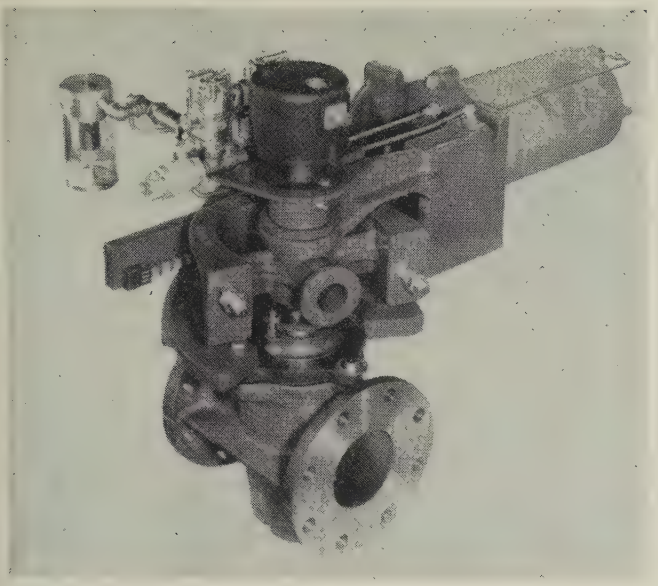
The Thwing-Albert fotosize penetration tester is made by Thwing-Albert Instrument Co. at Penn St. and Pulaski Ave. Philadelphia 44, Pa.

DEZURIK

The DeZurik Corp., Sartell, Minn., has just announced the release of a new electric-hydraulic basis weight control valve. The unit consists of a DeZurik vee-port stock throttling valve, a cylinder actuator, solenoid valves, and a precision position transmitter. Suitable control stations and position recorder can be furnished to provide very accurate control and read out.

A hydraulic cylinder is used to rotate the valve plug. A cylinder was selected rather than an electric motor since it is more economical and far easier to maintain. A hydraulic cylinder insures absolutely positive control due to the relative incompressability of water. The cylinder is made out of bronze, the piston rods of stainless steel to resist galling and corrosion. A filter is furnished, piped to the unit.

Two 3-way solenoid pilots are manifold mounted on the actuator and piped to the cylinder. The pilots have a "plug in" feature so that either pilot can be replaced by simply re-



New DeZurik basis weight control valve

moving two of the bolts, lifting the valve off the manifold, and bolting a new pilot in place. To move the valve, one solenoid exhausts one side of the cylinder while the other admits water to the other side of the cylinder. A speed control valve is piped to the exhaust of the solenoid to provide completely adjustable speed control.

A precision electric position transmitter is mounted on the actuator and connected to the valve pulg to show exact valve position. The transmitter has a 0–50,000 ohm slide-wire with a maximum rating of 400 v. across the full coil. A visual indicator is also provided to show valve position and the valve can be set manually in case of power failure.

A manual control station can be furnished to provide a very accurate economical means of controlling the valve. It has a vernier u-turn counter dial with 1,000 divisions and it can be set to one half a division giving 2000 repeatable valve positions.

This unit is especially applicable for use with a beta gage for automatic basis weight control. The output from the beta gage can be used to control the valve through suitable instruments.

Goodyear

Volume production of the first extruded, plastized polyvinyl chloride film approved for food packaging by the Pure Food and Drug Administration and offered on a commercial basis, has been announced by The Goodyear Tire & Rubber Co.

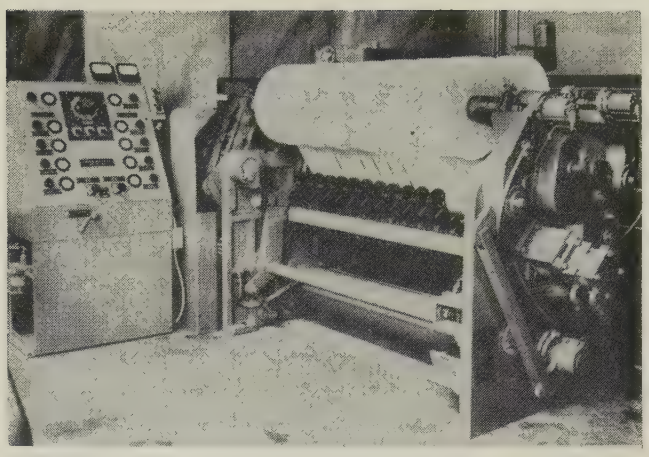
Called Vitafilm F, the new 1-mil product is being marketed with a manufacturer's price of 73c per lb. It has a yield of 21,500 sq. in. per lb.

E. H. Dours, the firm's packaging films sales manager, said the film can be utilized either in straight or overwrap applications, and readily laminates to paper, film, or foil to produce special pouch-type packages.

Cameron

Cameron Machine Co., Dover, N. J., has announced the opening of a new testing and development department. This new department has complete facilities for experimental and demonstrating slitting, rewinding, and unwinding of all types of flexible webs. Cameron's unique department was initiated to fill a need in the industries they serve. It provides the only complete facilities available in this country for the purpose of establishing, improving, and demonstrating techniques and basic methods of slitting, roll production, and web control.

Included in the machinery in this new department are duplex combination winders, center wind duplex machines, and two drum winders. All the machines are equipped with the recognized slitting elements such as score-cut, pioneered by Cameron; "Tru-Shear"; razor-cut, both fixed and oscillating types; and Sealcut for hot knife slitting and sealing. New experimental slitting methods are also designed and applied where required.



Shown here is the Cameron Model 628 duplex winder installed in Cameron Machine Co.'s new Testing and Development Department at Dover, N. J. This is one of several machines in this department set-up for the purpose of establishing, improving and demonstrating techniques and basic methods of slitting and rewinding

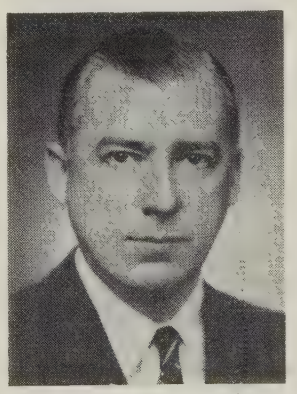
The winders are equipped with a variety of web control devices. Among these devices are pneumatic tensions; oscillating unwind stands; the new Cameron Web-Trol; photoelectronic line and edge guiding devices; hydraulic-pneumatic edge guide apparatus; and a control system to provide a fixed minimum draw from the rewind drum to the rewinding rolls when center winding on duplex combination machines.

Since the completion of the new department many companies have employed the facilities to advantage in learning how to run new materials and how to improve methods of handling older materials.

Cameron has opened the facilities of the new testing and development department to all companies with slitting and roll winding problems. Arrangements to have test runs and demonstrations can be made by contacting either the sales or engineering departments at the Dover, N. J., plant.

Stein, Hall

Election of Kenneth Arnold as a vice-president of Stein Hall & Co., Inc., and the appointment of John R. Lindquist to the managership of the paper and corrugating department was announced on March 1 by Lawrence Gussman, the firm's president.



Kenneth Arnold, Stein, Hall & Co.

J. R. Lindquist, Stein, Hall & Co.

F & P

New catalog 10D1416 gives complete information on the Fischer & Porter obstructionless magnetic flowmeter for metering difficult liquids such as concentrated acids and alkalis, slurries, paper pulp, waste slugdes, sewage, pigment dyes, starch solutions, food products, black liquor, and similar corrosive, abrasive liquids. For a free copy, write Fischer & Porter Co., 38 Jacksonville Rd., Hatboro, Pa.

A series of five Specifications Sheets 51-11001B—1 to 5 gives full technical data on F&P indicating and controlling instruments designed especially for use with the new "obstructionless" Fischer & Porter Magnetic Flowmeter. Write Fischer & Porter Co. 834 Jacksonville Rd., Hatboro, Pa.

OBITUARIES

George Archibald Cruickshank

George A. Cruickshank, Chief Bacteriologist of the National Aluminate Corp., Chicago, Ill., died of a heart attack on March 16, 1959.

Mr. Cruickshank was born in Providence, R. I., on Oct. 26, 1903, and studied at Rhode Island State College, Brown University, and received his M.Sc. degree in bacteriology from McGill University in 1926.

He was employed as an instructor or a bacteriologist by Rhode Island State College, Western Pennsylvania Hospital, Tucson Chemical Laboratory, Rhode Island Dept. of Agriculture, Union Wadding Co., Asthura Research Foundation, and joined the National Aluminate Corp. organization in 1946 as chief bacteriologist.

Mr. Cruickshank became a member of the Technical Association of the Pulp and Paper Industry in 1947 and was active in the work of its Microbiological Committee.

Franklin E. Frothingham

Franklin F. Frothingham died very suddenly on Feb. 22, 1959, a year after his retirement as Vice-President of Bird Machine Co., South Walpole, Mass.

F. E. Frothingham

Mr. Frothingham was born in Salisbury, Mass., on April 30, 1892. He attended Newberryport (Mass.) High School. From 1921 to 1923 he was President of Boston Belting Co. He joined the Bird Machine Co. organization in 1927 and served for many years as manager of the company's mid-western office at Evanston, Ill., before returning to the home office in South Walpole as Vice-President and Manager of pulp and paper machinery sales. At one time he was the chairman of the Association of Pulp and Paper Machinery Manufacturers. He became a member of the Technical Association of the Pulp and Paper Industry in 1929.

Otis Harold Knapp

Otis H. Knapp, Technical Assistant to the Division Manager, New York & Pennsylvania Co., Johnsonburg, Pa., died on Dec. 15, 1958.

Mr. Knapp was born in Salona, Pa., on Aug. 14, 1895, and graduated from Pennsylvania State College in 1925.

Mr. Knapp began employment with the Castanea Paper Co. in 1916 as a chemist and continued with the New York & Pennsylvania Co. throughout his career.

His body was interred in McKean Memorial Park in Lafayette, Pa.

Mr. Knapp became a member of the Technical Association of the Pulp and Paper Industry in 1938.

Lewis Carl Oseland

Lewis C. Oseland, assistant to the Manager of market research and development of the Alloy Tube Division, Carpenter Steel Co., Union, N. J., died on Jan. 6, 1959, at his home in Kenilworth, Ill.

Mr. Oseland was born in Superior, Wis., on Dec. 13, 1903. He attended Minnesota College and Lewis Institute. He began his career in the steel business at the Gary Works of the U. S. Steel Corp. He invented a process for taking the temperature of molten steel and the temperature responsive devices. He became Assistant General Manager of the Kentucky Fire Brick Co., a U. S. Steel subsidiary.

In 1946 he joined the Carpenter Steel Co. organization as Midwest District Sales Manager.

Mr. Oseland is survived by his widow Bernice, and two sons, Robert Lewis and Glen Arthur. He was buried in Oak Hill Cemetery, Neenah, Wis.

He became a member of the Technical Association of the Pulp and Paper Industry in 1955.

Charles J. Sibler

Charles J. Sibler, Chief Engineer of the West Virginia Pulp & Paper Co., died of a heart attack on March 12, 1959, at his home in New York City.

C. J. Sibler

Mr. Silber was born in Zurich, Switzerland, on April 16, 1896, and graduated as a mechanical engineer from the Swiss Federal Polytechnic Institute of Zurich in 1920.

Following graduation he became a junior engineer for the General Electric Co., Lynn, Mass. In 1922 he became a proposal engineer for the Westinghouse Electric Co. in South Philadelphia. He became a development engineer for the Brooklyn Edison Co. in 1925 and was a power engineer for Henry L. Doherty Co. from 1926 to 1929. From 1929 to 1936 he was Assistant Manager of the Steam Division of Foster Wheeler Corp. and in 1936 he joined the engineering staff of the West Virginia Pulp and Paper Co. as supervisor of Power. In 1945 he became Chief Engineer of the company. He directed the engineering of the 200-million dollar postwar expansion of the company.

Mr. Sibler took an active part in the affairs of the Technical Association of the Pulp and Paper Industry serving as Chairman of its Steam and Power Committee, General Chairman of the Engineering Division and as a member of the TAPPI Executive Committee from 1953 to 1956.

Interment was in Ferncliff Cemetary, Ardsley, N. Y. He is survived by a son, Carl, three brothers and three sisters in Switzerland.

TAPPI DIVISIONS AND COMMITTEES

Reports of Activities

Executive Committee

The Executive Committee of the Technical Association of the Pulp and Paper Industry met at the Commodore Hotel on Sunday, Feb. 22, 1959, at 10:30 a.m.

Members of the committee present were W. D. Harrison, J. R. Lientz, H. M. Annis, P. S. Bolton, O. W. Callighan, H. S. Spencer, B. T. Briggs, J. R. Curtis, K. G. Chesley, J. P. Weidner, P. S. Cade, F. P. Doane, Jr., J. H. Heuer, and J. J. Koenig. Members-elect to the Executive Committee present were F. S. Klein, W. C. Bloomquist, L. G. Rolland and H. O. Ware. Past-presidents present were K. O. Elderkin, K. P. Geohegan, A. E. Bachmann, G. W. E. Nicholson, V. P. Edwardes and Allen Abrams. J. L. Parsons, chairman of the Research Appropriations Committee, and R. G. Macdonald, P. E. Nethercut, and Alex Reid of the headquarters staff were also present.

Joint Advisory Council

W. D. Harrison summarized the suggestions made at the meeting of the Joint Advisory Council immediately preceding the Executive Committee meeting. Among the proposals made were the following: chairmen of Districts should be invited to attend Local Sections Operations Committee meetings as full committee members; Local Section vice-chairmen should also attend these meetings; meetings of Sections should be scheduled to avoid conflicts with other Section meetings; a committee of two or three persons in addition to J. L. Parsons should be appointed to review the research policy of the Association; the Executive Committee should appropriate funds for the preparation and distribution of paper industry recruitment brochures to college students in technical courses.

College Text Book

P. S. Bolton, reported that Volume II of the College Textbook has been completed, and all but two chapters of Volume I have been printed. These books are in use at four universities.

Local Section Rebates

The Executive Committee voted that the president appoint a committee to make recommendations on a policy concerning the future handling of local section rebates.

The president appointed H. O. Ware, chairman, B. T. Briggs and J. P. Weidner to study local section dues and rebates and to consider if it be necessary to amend the Association Constitution to establish a uniform national policy. This study would include consideration of the following questions: should a fixed percentage of the dues be automatically rebated, how should local section membership be defined, should geographical areas for local sections be delineated, and which local section will receive the rebate for a man belonging to more than one section?

Research Appropriations Committee Report

J. L. Parsons, chairman of the Research Appropriations Committee, summarized the Association's research activities during 1958. His full report was published in *Tappi* (March 1959).

In accord with the suggestion made at the meeting of the Joint Advisory Council the president appointed the following committee: J. R. Curtis, chairman, J. H. Heuer, F. S. Klein and J. L. Parsons to study the overall research appropriation policy of the Association.

Constitution Amendment

The procedure to be used for presenting the proposed amendment to the Association Constitution at the February 23rd annual meeting was discussed and approved.

Regulations Governing Standards

The Executive Committee voted that the revised Regulations Governing Standards proposed by the Standards Committee in its January 16, 1959, memorandum be adopted. These revisions incorporated the following changes: (1) methods are to be submitted to a written rather than verbal ballot of the responsible committee; (2) the channel of communications is to be between the Standards Committee and the Divisions rather than between the Standards Committee and committees; (3) the wording is revised to improve clarity and readability.

Appointment of Nominating Committee

The following members were appointed to the 1960 Nominating Committee: Principals—C. A. Young, E. O. Ericsson, J. R. Lyon, R. H. Simmons and R. C. Germanson; Alternates—N. Shoumatoff, H. Bialkowsky, R. W. Porter, S. K. Hellberg and Glen Sutton.

Study Group of European TAPPI Members

A letter from T. Nevrell of the Swedish Cellulose Engineers Association was read. The Executive Committee voted that the president write to Mr. Nevrell advising him that TAPPI has no purpose or desire to organize local sections in countries outside the U.S.A., but that it will listen to requests from groups that may wish to organize in other countries and will act upon them according to their individual merits.

Investment Advisory Committee

G. W. E. Nicholson presented a review of the activities of the TAPPI-Irving Trust Co. Advisory Custodian Account. The Executive Committee voted to accept the verbal report of the Investment Advisory Committee, to designate the Irving Trust Company of New York City as advisory custodian of the securities of the Association, and to delegate authority to G. W. E. Nicholson, chairman of the Association's Investment Advisory Committee to approve recommendations of the Irving Trust Co.'s Advisory Custodian Service to buy and sell securities for the TAPPI-Irving Trust Co. Advisory Custodian Account.

Signature for Association Checks

It was voted that P. E. Nethercut be bonded and authorized to sign Association checks. It was further agreed that all Association checks should be signed by two authorized members of the Association staff rather than by merely one.

Special Committees

J. R. Lientz appointed the following committees to serve until the 1960 Annual Meeting:

Investment Advisory—G. W. E. Nicholson, chairman, J. R. Lientz and H. M. Annis to work with W. N. Owen of the Irving Trust Company.

A.P.P.A. Technical Committee—J. R. Lientz, H. M. Annis and H. F. Lewis. P. E. Nethercut was requested to attend meetings of this committee to assure TAPPI representation.

Retirement Committee—J. R. Lientz, H. M. Annis, V. P. Edwardes (1 year), G. H. Pringle (2 years), and G. W. E. Nicholson (3 years).

Research Appropriations Committee—Abbott Byfield, Kimberly-Clark Corp., Glen T. Renegar, Container Corp. of America and J. J. Thomas, S. D. Warren Co. for three years to succeed V. P. Edwardes, J. H. Heuer and G. J. Brabender, whose terms have expired. J. R. Lientz and H. M. Annis will be members ex-officio.

Publications Management Committee—H. M. Annis, chairman, W. C. Bloomquist, F. P. Doane, Jr., J. J. Koenig and J. P. Weidner.

Editorial Board—M. S. Kantrowitz, R. C. Masterman, J. G. Patrick, J. R. Sanborn, F. R. Sheldon, H. A. Spencer and R. S. von Hazmburg for three years to succeed J. P. Casey, C. G. Krancher, J. D. Lyall, C. S. Maxwell, J. J. Perot, B. F. Shema and Arthur Thurn.

Chemical Engineering Problems

It was voted that $2000 be appropriated for use by the Chemical Engineering Committee to arrange for the preparation of a set of chemical engineering problems to be used in colleges and universities.

Wax Paper Samples

It was voted that $1000 be appropriated for the use of the Wax Testing Committee to purchase a supply of standard reference paper to be used for the testing of waxes.

Education Conference

A sum of $3000 was appropriated for a 1959 APPA-TAPPI Educators' Conference to acquaint professors with technical problems in the paper industry.

Paper Industry Recruitment Brochure

It was voted that $6000 be appropriated for the preparation of a brochure to be used for the recruitment of college technical students for the pulp and paper industry.

Italian Local Section

The Executive Committee approved the request of "The Association of Italian Members of TAPPI" for a local section charter, provided that this section would accept the revised Articles of Organization. These revisions were suggested to conform with operating policies and practices in other TAPPI Local Sections.

1958 Financial Statement, Audit and 1959 Budget

The Executive Committee approved the 1958 Financial Statement, the 1958 Audit and the 1959 Budget as amended by additional appropriation authorized at this meeting.

Five-Year Forecast

A five-year forecast of Association activities prepared by the headquarters staff was discussed. President Harrison requested that each member of the Executive Committee review the forecast and submit his comments to the headquarters staff. The headquarters staff was requested to keep the officers informed about such suggestions and comments.

Headquarters Staff Appointments

The Executive Committee appointed R. G. Macdonald as Assistant to the President and P. E. Nethercut as Secretary-Treasurer.

The meeting was adjourned at 5:00 p.m.

P. E. Nethercut, *Secretary-Treasurer*

Coating and Graphic Arts Division—1958 Report

There are two major committees in the Coating and Graphic Arts Division. These committees are the Coating Committee and the Graphic Arts Committee. The membership of both committees have a high level of interest in committee work. The Coating Committee continues to operate with the five man Coating Council with the chairman of the committee also functioning as chairman of the Coating Council. The Graphic Arts Committee is headed by a chairman assisted by three vice-chairmen with responsibilities as follows: Tom Irwin, publicity, W. C. Walker, technical activities, and Miss Jacqueline Fetsko, technical papers and programs.

The members of both committees are attempting to carry out a program which will encompass the six items defined in the Constitution of the Association as its objectives.

Conferences

The Coating Committee held its Ninth Coating Conference at Bedford Springs, Pa., on May 14–16, 1958. Over 600 people attended the meeting. The quality of the technical program was good. The financial report of the conference indicates a small profit to National TAPPI. Future conferences are planned through 1963.

The Graphic Arts Committee conducted two technical sessions during 1958. One of these sessions occurred in conjunction with the 1958 annual meeting in New York and the second technical session was presented at the October Testing Conference in Savannah. A Graphic Arts session has been planned for the 1959 national TAPPI meeting.

Publications

The annual Coating Conference of the Coating Committee provides papers for publication in *Tappi*. In addition, the Coating Committee published a revision of Monograph No. 7 titled, "Pigments for Paper Coating." Further publications in the coating field will continue to come from the Coating Committee.

The Graphic Arts Committee supply technical papers for publication in *Tappi* as a result of technical sessions held during the year. The Surface Strength Subcommittee has the objective of publishing a TAPPI Standard method for the measurement of the surface strength of paper.

Research

The Coating Committee has continued to sponsor the research project, "A Study of Flow Properties on Paper Coating Mixes" at the University of Maine. Fred C. Goodwill still serves as the liaison administrator for the Coating Committee and coordinates with a Steering Committee composed of Dr. Mattson of Oxford Paper Co. and Dr. Hemstock of Minerals & Chemicals Corp. The Coating Committee has one new research project which may mature into an appropriation request in 1959 or 1960.

The Graphic Arts Committee have been conducting research under TAPPI Appropriate Request No. 130 at Lehigh University. This project is titled, "Techniques for the Evaluation of Surface Strength of Printing Papers." The project has used the $10,000 supplied by National TAPPI and an additional fund of $4000 contributed from the Printability Research Fund at Lehigh University. The subcommittee responsible for this project has as members Alex Glasssman, chairman, Walter Roehr, and William C. Walker. In this research an attempt has been made to evaluate all of the commercially available instruments for surface strength measure-

ment and to conduct a round robin test with about thirty outside laboratories. The program has been well planned and pursued with vigor but the work has not progressed far enough to provide a standard method or a satisfactory instrument. Further research is indicated. The Graphic Arts Committee will submit a second research appropriation request in 1959 and in addition initiate a new research appropriation request for studies on ink receptivity.

The Coating and Graphic Arts Division will submit at least three and possibly four research appropriation requests to National TAPPI in 1959.

PERSONNEL

The Coating Committee continues to be a strong organization operating in many areas of technical activity. The full scope of the activities of this committee are covered in the annual report of the committee as prepared by Alfred Bonanno of the Kelco Co. who presided as chairman. Joseph Loomer has accepted the responsibility for this committee during 1959. Leadership for the Coating Committee has now been provided through 1963.

Charles Morton of Kimberly-Clark Corp. continues to chairman the Graphic Arts Committee. Mr. Morton has accepted the responsibility of this committee for 1959. In addition to the prosecution of their current technical interest, the Graphic Arts Committee plan further reorganizational changes during 1959 to strengthen its committee and broaden its scope of activity.

Richard Trelfa has accepted the chairmanship for the Coating and Graphic Arts Division during 1959. At the February national meeting of TAPPI, a new secretary should be selected for the Division.

The division and both committees have drawn heavily on the headquarters staff during 1958 and will continue to do so during 1959. We believe that the good services rendered by the headquarters staff should be acknowledged in this report. There is no doubt that the guidance and assistance given in the technical division is contributing to a stronger TAPPI organization which can more effectively carry out the objectives of national TAPPI.

Corrugated Containers Division

A meeting of the Corrugated Containers Steering and Advisory Council was held at the Commodore Hotel, New York, N. Y., Feb. 23, 1959.

The meeting was attended by the following:

R. L. Jenk, The Mead Corp.
B. Mendlin, Cornell Paperboard Products Co.
W. P. Blamire, American Box Board Co.
W. C. Kline, Container Corp. of America
R. D. Merrill, Stone Container Corp.
K. Provo, Gaylord Container Corp.
K. R. Martin, Olin Mathieson Chemical Corp.
D. C. Shepard, Menasha Wooden Ware Corp.
J. J. Koenig, Gaylord Container Corp.
P. J. Cox, Consolidated Water Power & Paper Co.
L. K. Burnett, Ohio Boxboard Co.
H. T. Scordas, Union Bag-Camp Paper Corp.
J. H. Rooney, Jr., Continental Can Co.
R. W. Buttery, Bathurst Power & Paper Co. Ltd.
R. H. Bowers, Connelly Containers, Inc.
R. Hutcheson, Union Bag-Camp Paper Corp.
E. O. Knapp, W. Va. Pulp & Paper Co., Hinde & Dauch Div.
H. G. Nelson, Owens-Illinois Glass Co.
H. O. Teeple, TAPPI

Minutes of the Previous Meeting. The minutes of the Nov. 4, 1958, meeting were approved as written.

Election of Division Officers. The following nominations were made by the nominating committee:

For chairman—R. L. Jenk
For vice-chairman—B. Mendlin
For secretary—W. P. Blamire

Corrugated Container Steering and Advisory Councils

No other nominations were presented and the above were elected.

It was then moved, seconded, and approved that henceforth the election of Division and Committee officers will be made at the fall conference. The men so elected will take office on January 1 following.

R. L. Jenk appointed L. K. Burnett as chairman of the nominating committee for next fall. Assisting him on the committee will be H. T. Scordas and D. Long.

Report on Status of February, 1959, Meeting. H. G. Nelson, general chairman, summarized the program planned for the three technical sessions on February 24 and 25. He paid tribute to the excellent work done by his moderators and the TAPPI staff.

Speaker Evaluation Program. After much discussion, and an explanation of the purpose of the program by H. Teeple, it was decided to go ahead with this program on a strictly voluntary basis. It is the responsibility of the general chairman and moderators to acquaint the speakers with the program. If the speaker is willing to be evaluated he may have the option of selecting those persons to make the rating, or accept the complete anonymity of the moderator's selection.

H. G. Nelson is to report to the Steering Council on the reaction of the speakers at this conference to the evaluation.

REPORTS OF COMMITTEE CHAIRMAN

Production Committee. K. Provo, chairman, reported on the progress of this committee.

An appropriation for $500 has been obtained to carry out the project on adhesive consumption.

A second project, on the study of supervision, is nearing completion. It is expected that this material will serve as a basis for a good paper.

The following nominations for committee officers will be submitted at the committee meeting Feb. 24, 1959:

For chairman—R. W. Buttery
For vice-chairman—D. Blackburn
For secretary—L. Ashwood

K. Provo was asked by R. Jenk to serve on the Advisory Council so that the benefit of his services might be retained.

Process and Quality Control Committee. K. R. Martin, chairman, reported on the progress of this committee.

Five projects are under way in this group. One of these, a list of laboratory equipment for use in our industry, has been prepared for distribution during the technical session Feb. 24, 1959.

It was pointed out that there is generally a conflict between the scheduling of meetings of this committee and the Container

Testing Committee. R. Jenk is to write H. Teeple asking him to see what can be done about this.

The following nominations for committee officers will be submitted at the committee meeting Feb. 24, 1959:

For chairman—K. R. Martin
For vice-chairman—H. Seibel
For secretary—H. Dunholter

Engineering Committee. R. Merrill, chairman, reported on the progress of this committee.

Four projects have been under way. Two of these are nearing completion. A new project on medium take-up factors will be initiated.

R. Hutcheson is being nominated as chairman of the committee.

R. Jenk asked R. Merrill to serve on the Advisory Council so that the benefit of his services might be retained.

Industrial Engineering Committee. W. C. Kline, chairman, reported on the progress of this group.

After a slow start, this group is getting actively under way. A discussion of potential projects is planned for Feb. 24, 1959.

The following nominations for committee officers will be submitted at the committee meeting Feb. 24, 1959:

For chairman—W. C. Kline
For vice-chairman—T. W. Carroll
For secretary—R. S. Owen

Raw Materials Committee. D. C. Shepard, vice-chairman, reported on the progress of this group. Work is actively under way on several projects, but project numbers are yet to be assigned.

The Ink Subcommittee may sponsor a series of workshop sessions in different locations on inks, dies, presses, and makeready.

The following nominations for committee officers will be submitted at the committee meeting Feb. 24, 1959:

For chairman—D. C. Shepard
For vice-chairman—M. Block
For secretary—G. R. Wilmer

Meetings

Fall 1958 Meeting. E. O. Knapp gave a final report on the 8th Corrugated Containers Conference, Nov. 5 and 6, 1958. The report of the activities of the Registration Committee should be of great assistance to the planning of future conferences.

Fall 1959 Meeting. J. H. Rooney, general chairman, reported on the progress to date. Hotel arrangements are set for Sept. 15–17, 1959. Two plant tours are scheduled, one through the Continental Can Co. box plant, and the second through Gaylord's multiplant operation at Bogalusa.

A headquarters room will be set up for wives of registrants, but no program will be prepared. Extra dinner and plant tour tickets will be available for purchase at the time of registration.

Authorization was given Mr. Rooney to sign up a tentatively scheduled after-dinner speaker.

One session will be handled by R. Hutcheson as moderator. The general theme to be "Engineering Advances Contributing to the Reduction of Scrap." The following talks are tentatively scheduled:

1. Warp control by heat on doublebacker belts and glue application at the doublebacker.
2. Areas where engineering still needs to be done to reduce scrap.
3. Knife accuracy control.
4. Web alignment control.

The second session will be sponsored by the Raw Material Committee. The general theme: "What is required in corrugated board to compete with the demands of modern packaging?"

Moderators should submit titles of papers and information on authors directly to H. O. Teeple. Copies of the covering letter to J. H. Rooney will keep him informed.

February 1960 Meeting. R. Bowers has accepted the job as general chairman of the February, 1960, meeting.

K. Provo believes that the production committee will be in position to sponsor the entire technical program. Possible subjects might include: sales service, expediting, or sales service as it affects operations.

Messrs. Bowers and Provo will proceed on this basis. Moderators will be selected at the Production Committee meeting, Feb. 24, 1959.

Fall 1960 Meeting. R. Buttery has accepted the job as general chairman.

The Raw Materials Committee will sponsor one session, probably on ink and related subjects as that would fit in well with the plant tours because of the high quality printing in that area.

The Process and Quality Control Committee will sponsor the second session. A possible theme would be in packaging.

Advisory Council. R. Jenk appointed the vice-chairman of the division as the chairman of the Advisory Council. This would be a permanent setup to coordinate and screen projects and to stimulate research activities.

The first project for this group should be a method to publish the work of the division in a usable form.

Activity Bulletin. The reaction to the Activity Bulletin distributed at the Fall 1958 Conference was favorable and a similar bulletin is to be prepared for the fall 1959 meeting. H. Teeple requested that this be submitted to him by the middle of August so that there will be adequate time for its reproduction.

Operating Manual. The need for a more detailed operating manual for incoming committee chairman was recognized. L. Burnett was appointed chairman of a committee (which he will select) to prepare such a manual within the frame work on the present TAPPI Guide to Committee Chairmen.

Registration Fees. The fee differential at the Fall Conference was raised to $3.00. This is a step in the move to a $5.00 differential between TAPPI members and nonmembers, as is the case in other conferences.

It is hoped that the conference budgets can be figured more closely than in the past so that lower registration fees and reduced surpluses will be possible.

Site of Fall 1962 Conference. The Detroit Convention Bureau has invited the group to hold the 1962 conference in that city. As an enticement, they are offering train service between the plants in the plant tours and to the Ford Motor Co.

There was some question as to whether the location was far enough to the East. Alternate sites suggested were Pittsburgh and Boston.

H. Teeple is to explore the possibilities of extra attractions in Pittsburgh and Boston to compete with Detroit's offer. After this has been checked, the secretary will poll the members of the Steering and Advisory Councils on the location.

W. P. Blamire

Industrial Division—1958 Annual Report

As the Industrial Division consists of five unrelated committees, there is no over-all program for the division. Below are given summaries of the activities of four of these committees for 1958. The Nonfibrous Raw Materials Committee is in an inactive status at this time.

Agricultural Fibers Committee

This committee held its annual fall meeting on October 15 and 16 at Columbus, Ohio, with 32 people in attendance. In addition to technical sessions, visits were made to the plants of Gaylord Container Corp. in Baltimore, Ohio, and Dresden, Ohio.

The cooperative program for the evaluation of continuous pulping of wheat straw is well under way. Several trial runs have been made at the pilot plant in Berlin, N. H., and results are now being evaluated by the Northern Utilization Research and Development Division of the Agricultural Research Service, Peoria, Ill. This work should be completed during 1959.

Training and Education Committee

This committee confined its activities during 1958 to the writing and production of the "Pulp and Paper Textbook for College Students." This book is being published by offset lithography in loose-leaf form and will be used for a year or so by college students and revisions made before the volume is published in permanent bound form. The loose-leaf production consists of two volumes and includes 31 chapters with 30 authors participating in the writing of this textbook.

Ten of the 15 chapters of Volume I have already been issued and are in use by several institutions sponsoring programs in pulp and paper technology. The first seven chapters of Volume II have been published, and it is expected that the remaining nine chapters will be printed and ready for use by the middle of February, 1959. Every effort has been made to reduce the cost of this book so that it will be readily available to college students at a nominal price. The two loose-leaf volumes, complete with binders, are being sold at the present time for $5.00 each or at a total cost of $10 for each student.

Structural Fibrous Materials Committee

The test board forming equipment is being evaluated by various laboratories. Two drainage testers have been tested by several laboratories, and these studies are continuing. Routine Control Method RC-246 covering this tester has been issued. Studies were started on a laboratory test for water absorption of insulating board. A proposed tentative standard procedure for the determination of consistency of insulating board stocks submitted to the Standards Committee was returned with the suggestion that insulating board stock should be included in the general consistency method being prepared by the Pulp Testing Committee.

Water Committee

Two symposia were presented at the 1958 annual meeting. The first was on "Well Field Management" and the other on "Purification Capacity of Streams." One task group has prepared a proposed standard of definitions and terms relating to water. Task groups are working on proposed standards for turbidity, iron, hardness and solids.

W. H. Aiken, *General Chairman*

Coating Committee—1958 Report

During the past year the Coating Committee has functioned within the organization procedures as set up by TAPPI and under the directorship of the Coating Council.

Meetings

Coating Committee meetings were held on Feb. 18, 1958—TAPPI Convention, New York, N. Y., and May 15, 1958—Coating Conference, Bedford Springs, Pa.

Coating Council meetings were held on Feb. 17, 1958—TAPPI Convention, New York, N. Y., May 13, 16, 1958—Coating Conference, Bedford Springs, Pa., and Oct. 24, 1958—TAPPI Headquarters, New York, N. Y.

Minutes of the meetings were sent to all members of the Coating Council and Coating Committee, respectively.

A Council meeting and Committee meeting is scheduled to be held during the week of Feb. 22, 1959.

Report on Coating Committee Projects

No. 302. Monograph on Raw Stock for Coating (G. McKnight, *chairman*). This subcommittee has held several meetings during the year to outline the work that should be covered under the project and to recruit additional members to work on the committee. The outline has been accomplished and a report will be made in February. A questionnaire for technical data was sent to all mills producing coated paper.

No. 303. Monograph on Defoaming, Waxes & Misc. (W. Sowerbutts *chairman*). The chairman of this subcommittee resigned and a new chairman was appointed at the May Conference at Bedford Springs. He has reviewed the file on this project and reports that he is in a position to pursue this work. At the last Council meeting it was agreed to change the title of the project to "Monograph on Coating Additive." This would serve to broaden the scope of the monograph. A report of recent progress will be made at the annual meeting in February.

No. 536. Research Project No. 111—Study of Flow Properties of Coating Mixes (Research, University of Maine; F. Goodwill, *liaison;* G. A. Hemstock, *chairman*). A great deal of time and effort has been spent on this project during the year. Two appropriations, totaling $5116.09, granted by TAPPI, were used for research being conducted at the University of Maine.

Work has been progressing at the university and at the last meeting it was indicated that all of the subjects except item (*d*) "An Analysis of Rheograms Made From Coating Colors Using Various Amounts of Additives" would be completed. A steering subcommittee has been formed to review the past work and to guide future work being done on this project. This committee has held several meetings and has shown to be very constructive in this type of research project.

A paper on the completion of the "Statistical Analysis Work" will be prepared and presented at the next Coating Conference. Continuation of this work will be considered at the February meeting after a report is made by the steering committee and a proposal is submitted by the University of Maine.

F. C. Goodwill has been the liaison representative for the Coating Committee during the past year. Dr. Mattson and Dr. Hemstock are on the steering committee for this project with Dr. Hemstock as chairman.

No. 569. Revision of Monograph No. 9—Proteins and Synthetic Adhesives (L. H. Silvernail, *chairman*). This project is progressing very nicely and the committee has been very active in rewriting this monograph. Publication of the revised monograph will be accomplished in the near future.

No. 598. Survey of Drying Methods of Coating Paper (L. W. Egan, *chairman*). A formal report is being prepared by the subcommittee and will be presented at the February meeting. Very little progress has been made during the past year.

No. 599. Survey of Factors Effecting Coat Weights. At the February, 1958, Coating Committee meeting the chairman of this subcommittee requested to be relieved of this project. A motion was then made, seconded, and passed "that this project be discontinued pending a thorough review and selection of a chairman." No further action has been taken.

No. 600. The Effect of Pigment Combination and Coating Solids on Particle Packing in Paper Coatings and Sheet Characteristics (R. Hagemeyer, *chairman*). A formal paper was presented at the May Coating Conference and work is still continuing. This subcommittee has been very active during the past year and recommendations are forthcoming for continuation of this project possibly as a TAPPI sponsored research project.

Pigments for Paper Coating—Revision of Monograph No. 7 (W. R. Willets and R. W. Hagemeyer, *Co. chairmen*). This monograph has been revised and completed and was mailed out by TAPPI this month.

During the past year activity has developed to form ad-

ditional subcommittees for new projects to further increase the participation of committee members in committee work.

New Subcommittees

A subcommittee is being formed to survey and recommend new projects to be studied by the Coating Committee. J. Frankevicz, *chairman.*

1. A new subcommittee chairman has recently been appointed for the project of "Pigment Studied." W. Willets, *chairman.*

2. At the February meeting a subcommittee chairman will be appointed for the project "Adhesives Studies."

Items 1 and 2 were brought about by a survey conducted by Dr. C. Kesler to establish which fields of studies were of most interest to the members of the Coating Committee.

Coating Conference

This was the Ninth Coating Conference and was held at Bedford Springs, Pa., on May 14–16, 1958. This meeting was a successful one from a technical program point of view. There were 545 registrations with 614 people attending. Chester Landes was general chairman of this Coating Conference.

Plans are under way for the 1959 Coating Conference under the chairmanship of Frank Kaulakis. This conference will be held May 25–27, 1959, at the Hotel Statler, Boston, Mass.

Other coating conference dates and locations that have been set are as follows:

May 23–25, 1960—Edgewater Beach Hotel, Chicago, Ill.
May 15–17, 1961—Hotel Statler, Buffalo, N. Y.
May 21–23, 1962—Netherland Plaza, Cincinnati, Ohio.

Original dates of May 23–24 were approved to be changed to May 15–17 for the 1961 conference.

Liaison

The committee has continued liaison with the following organizations:

1. ASTM Committee D-25 "The Testing and Analysis of Casein": represented by John C. Rice, Lowe Paper Co.

2. The TAPPI Joint Advisory Committee on Printability: represented by Doyle W. Boggess, Beveridge Paper Co.

3. Committee on "Routine Test Methods": represented by John R. Gunning, Provincial Paper Ltd.

Deinking Committee

The TAPPI Deinking Committee met at the Hotel Biltmore, Dayton, Ohio, on Wednesday evening, Oct. 8, 1958, preceding the Third Deinking Conference. Twenty-three members and visitors were present as follows:

J. J. Forsythe, *chairman*
W. D. Boggess, *vice-chairman*
E. F. Andrews, *secretary*
A. M. Altieri, Tileston & Hollingsworth Co.
Arthur Brooks, Columbia-Southern Chemical Co.
J. L. Clouse, Oxford Miami Paper Co.
H. E. Corwin, Diamond Gardner Corp.
J. A. Dean, Hamilton Paper Co.
A. J. Felton, Black-Clawson Co.
R. W. Kumler, Waste Paper Utilization Council
W. A. Lozan, Provincial Paper Ltd.
J. Wayne Morrow, Newton Falls Paper Mill Inc.
R. W. Pattison, Berkshire Color & Chemical
W. D. Rice, P. H. Glatfelter Co.
J. W. Wendell, Jr., Tileston & Hollingsworth Co.
Merle R. Wilkins, Kalamazoo Paper Co.

Nonmembers
John Brown, Pacific Press, Inc.
Olin W. Callighan, Minerals & Chemicals Corp. of America
G. F. Huber, Diamond Gardner Corp.
G. W. Pixler, Diamond Alkali Co.
E. Suchhecki, National Starch Products, Inc.

TAPPI Staff
H. O. Teeple
P. E. Nethercut

Chairman James J. Forsythe, International Paper Co., Niagara Falls, N. Y., presided.

W. D. Boggess, Beveridge Paper Co., Indianapolis, Ind., reported on the results of the preliminary questionnaire sent out on "Methods of Determining the Suitability of Wastepaper for Deinking." Out of the 46 sent, replies had been received from 25. A second questionnaire will be sent to those who replied. It was suggested that a discussion and explanation of the purpose be included on the questionnaire. Mr. Teeple reported that TAPPI Project No. 732 had been assigned to this questionnaire. The results of this second questionnaire will be used as a basis for developing a standard laboratory method for deinking.

J. A. Dean, Hamilton Paper Co., Plainwell, Mich., reported that he had prepared a preliminary draft of a Deinking Practices questionnaire. This questionnaire has been assigned Project No. 733. Copies of it were distributed and Mr. Dean asked for comments. The following recommendations were made:

1. That where grades of wastepaper are listed, the list should be expanded.
2. That where "other grades" of wastepaper appears, it should be followed by "Please specify."
3. That under data pertaining to yield:
   (a) Wastepaper used should be on an as-received basis.
   (b) Per cent yield should be based on oven-dry wastepaper and oven-dry pulp.
4. That items under bleaching of deinked stock pertaining to shrinkage should be listed under the section pertaining to yield.
5. That the following items should be added to the yield section:
   (a) Per cent moisture in waste paper.
   (b) Per cent ash in pulp.
   (c) Method of determining shrinkage.

Mr. Altieri, Tileston and Hollingsworth Co., Boston, Mass., reported on the status of the committee's proposed research project on "Properties of Plastic Materials Found in Wastepaper." The proposal has been rewritten and resubmitted to the Research Appropriations Committee. Mr. Nethercut reviewed the procedures for considering and granting requests for research appropriations.

Mr. Felton, Black-Clawson Co., Middletown, Ohio, reported on the status of registration and final arrangements for the Third Deinking Conference.

The members unanimously voted to hold the Fourth Deinking Conference in the New England area in the fall of 1959. selection of an exact date and site was left in the hands of the Conference Committee.

J. W. Wendell, Jr., Tileston and Hollingsworth Co., Boston, Mass., was chosen to be conference chairman and H. E. Corwin, Diamond Gardner Corp., Palmer, Mass., was chosen to be program chairman for the conference

The meeting was closed in due order.

Note: Since the meeting the following information has been received:

1. The Research Appropriations Committee has turned down the request for funds for the Committee's research project, "Plastic Materials Found in Wastepaper."

2. The site and date of the Fourth Deinking Conference will be at the Hotel Bancroft, Worcester, Mass., Oct. 8 and 9, 1959. A Deinking Committee meeting will be held in the evening of October 7.

3. The Deinking Committee met Monday afternoon Feb. 23, 1959, during Paper Week.

E. F. Andrews, *Secretary*

Forest Biology Committee

Minutes of meeting of Subcommittee No. 2 on Tests and

Wood Quality Objectives held in the Commodore Hotel, New York, N. Y. Tuesday, Feb. 24, 1959. Present were:

* Peter T. Lannan, Jr., *chairman*, West Virginia Pulp and Paper Co.
* Robert M. Echols, Southern Institute of Forest Genetics.
* Harold L. Mitchell, U. S. Forest Products Laboratory.
* Louis Hiett, The Buckeye Cellulose Corp. (for F. E. Pollock).
Earl Stephens, The Champion Paper and Fibre Co.
Phillip R. Wheeler, Southern Forest Experiment Station.
* D. J. McLaurin, Institute of Paper Chemistry.
* Malcolm G. Lyon, The Champion Paper and Fibre Co.
Philip N. Joranson, Institute of Paper Chemistry.
Philip C. Wakeley, Southern Forest Experiment Station.
Philip R. Larson, Northern Institute of Forest Genetics.

* Members of subcommittee.

Prior to opening the meeting, Chairman Lannan checked the membership list and expressed concern about the lack of technical men from the papermaking industry and the preponderance of foresters in this meeting of Subcommittee No. 2. He felt that a more nearly equal representation of both fields would be desirable.

The meeting was formally opened at 2:15 p.m. by Chairman Lannan.

In view of the fact that copies of the lengthy minutes of the July meeting were sent to all members, the complete reading of the minutes was dispensed with by vote.

The appointment of Robert M. Echols as secretary of Subcommittee No. 2 was announced by the chairman, who also recommended that a vice-chairman be appointed for 1959.

The chairman asked for suggestions for the agenda for this meeting. Mr. Hiett relayed two suggestions by Mr. Pollock as follows:

1. Reading and discussion of Mr. Yundt's assigned report on the wood and fiber characteristics that influence sheet properties or processing considerations.

2. A suitable research project that would contribute to charge no. 2, namely, some simple, economic, and meaningful small-scale tests of pulpwood quality, applicable to individual living trees.

There followed a discussion about the qualities of paper that relate back to characters in wood and in trees. Mr. Mitchell was of the opinion that if industry is given volume, then they have the know-how to make the paper.

Further discussion by the committee brought out the fact that the problem is that the geneticists are asking the chemists and paper people to say what they want in a tree—and this has not been adequately defined. One way to solve the problem is to begin with the obvious limitations. The seed orchard question was raised.

Mr. Joranson stated that the big question is: What goes into a seed orchard? He suggested that we must at least certify to some stage of quality, therefore we need qualitative progeny tests, and need to get into the qualitative improvement of trees.

Mr. McLaurin reminded the group that we are in a changing industry—the needs are changing—perhaps they will not be the same five years from now, and consequently would have a bearing on seed orchard establishment or tree-evaluation for seed orchards.

It was noted that the report to have been given by Mr. Yundt was not prepared. Mr. Yundt resigned from the committee as he was leaving the industry to engage in his own business.

Referring to Mr. Mitchell's previous statement about volume, Mr. Hiett stated that quality objectives are not necessarily at variance with quantitative objectives. He asked, what variations can we get in nature? Which characters are best for us to investigate? He suggested that we list the characters (such as fiber length, specific gravity, etc.) and then undertake to determine the best methods to investigate them.

Mr. Lyon suggested that the chairman ask each member of the subcommittee to write down a paragraph or two about the various wood characters, then pass them around. In this way we can perhaps get together on the relationships.

Forest Biology Subcommittee II

Mr. Lannan replied that this idea was considered at the July meeting and 12 or 13 of the more obvious characters were listed. He suggested that each member take some of the characters and write a brief discussion about them. He further modified this idea by suggesting that perhaps three pulp and paper men divide up the list and write down the current thinking about the 12 characteristics.

Mr. McLaurin said that maybe we should find out what the foresters (on Subcommittee No. 2) think are important characters that influence wood quality and pulp quality.

Mr. Stephens then said that when the forester comes to the paper man and says, "What do you want in wood?" the paper man should reply "What can you give us?" He clarified this statement by adding that the geneticist should outline the ranges of variation that he can obtain, then the papermaker should run tests to determine what this range of variation in wood means in terms of papermaking.

After this discussion it was agreed the write-up of characteristics was a job for the paper men. Chairman Lannan formally asked the six paper men to write down their views. Each man is to write a paragraph or two on the characteristics listed in the minutes of the July meeting. The following men were named:

Malcolm G. Lyon
Malcolm N. May
F. E. Pollock
J. R. Salvesen
Robert J. Seidl
D. J. McLaurin

The chairman said that after the paper men report, the full subcommittee can review and comment on written material. If there are gaps misunderstandings, or differences of opinion, this will become apparent. Later the subcommittee can suggest the research that is needed. It is possible that some schools can take on some of the problems for graduate students.

It was further decided that when the papers come in they will be grouped and circulated. Therefore, each author was requested to discuss each of the items on a separate page or sheet of paper for easy grouping. Comments should be sent to the chairman in 15 copies so that they might be grouped and distributed to the membership of the committee for review and comment. The deadline for the reports by the paper men was set for April 30, 1959.

The chairman then opened discussion on recent work or developments within the scope of the subcommittee activity. He indicated that a review of accomplishments in this field would be one way this subcommittee can serve the industry.

Presentation of such material in the minutes of the subcommittee would bring this material to the attention of interested parties.

Mr. Mitchell stated that the Forest Products Laboratory has been developing fast methods for making chemical analyses of small samples. He said that he has cooperated with the Southern Forest Experiment Station in refining techniques for core-sampling trees. The Forest Service is currently making a sample of Arkansas timber resources on a scale that is equal to $^1/_{16}$ that of the Mississippi survey (using an eight-mile grid in Arkansas). It is expected that this survey will give some further answers on variation.

Mr. Mitchell also reported that a paper by Fassnacht of the Southern Forest Experiment Station will be published in the near future, reporting a method of determining tree specific gravity from increment core specific gravity. The method uses a regression formula that permits the determination of gross dry mass per tree (or per acre).

McLaurin reported that the Institute of Paper Chemistry has received an instrument from Sweden that measures fibers—called an Electronic Planimeter. Upon questioning, he suggested that persons desiring further information contact Jack Hankey at the Institute of Paper Chemistry.

Mr. Mitchell mentioned that the Forest Products Laboratory has received an instrument designed for fast, accurate measurement of accumulated summerwood in increment cores. It is based on a vernier principle.

Mr. Lyon stated that the papers presented at the current TAPPI meeting should be included in the activities of Subcommittee No. 2, because they were concerned with small-scale testing, particularly those presented by Messrs. Jayne and Echols.

Mr. Joranson mentioned that much work is being done in micropulping. This led to a discussion of micropulping techniques at the Institute of Paper Chemistry.

Mr. Echols said the ampliscope referred to in his paper at the technical session was written up in the January, 1959, *Journal of Forestry*. Reprints may be obtained from him at the Southern Institute of Forest Genetics, Gulfport, Miss.

Mr. Mitchell, referring back to the Arkansas Timber Survey, offered information on the range of variation in Arkansas and Mississippi trees, as determined by increment cores and survey measurements, to anyone who needs the data.

The chairman then called for further business.

Mr. Lyon asked if we should consider for the future an article for *Tappi*, listing the known sampling techniques and micromethods. He suggested that it could take the form of a bibliography.

Mr. McLaurin stated that a review of micropulping techniques would be useful. Therefore, a paper on microsampling methods, including techniques of gathering and processing material, would have merit.

After some discussion, the subcommittee favored a paper, possibly entitled: "Nondestructive Sampling of Trees and Testing of Samples."

The chairman stated that it was pointed out during the above discussion that most of these tests were reported by the Forest Products Laboratory in references in their various papers.

Mr. Lyon suggested that such a paper in the form of a bibliography would be an area in which the committee can serve.

Mr. McLaurin: "How about a review paper for the 1960 Forest Biology Committee meeting?"

The chairman directed the secretary to send a letter to John Duffield, suggesting such a paper for the 1960 meeting. Mr. McLaurin indicated that possibly the Institute of Paper Chemistry would prepare the paper, to cover the phases of sampling the trees and testing the samples.

The following is the current membership of the Subcommittee on Tests and Wood Quality Objectives:

T. W. Earle, Continental Can Co., Inc., Savannah, Ga.
Robert M. Echols, Southern Institute of Forest Genetics, United States Department of Agriculture Forest Service, 3505 25th Ave., Gulfport, Miss.
Peter T. Lannan, Jr., Chairman, Woodlands Division, West Virginia Pulp and Paper Co., Box 587, Georgetown, S. C.
Malcolm G. Lyon, Manager of Pulp Research and Development, The Champion Paper and Fibre Co., Hamilton, Ohio.
Malcolm N. May, Technical Director, Gulf States Paper Corp., Tuscaloosa, Ala.
Harold L. Mitchell, Forest Products Laboratory, United States Department of Agriculture Forest Service, Madison 5, Wis.
F. E. Pollock, Associate Director, Technical Division, The Buckeye Cellulose, Memphis 8, Tenn. (Louis A. Heitt substitute for February, 1959, meeting.)
J. R. Salvesen, Director of Research, Marathon Corp., Rothschild, Wis.
Robert J. Seidl, Director, Central Research, Simpson Timber Co., Seattle, Wash.
D. J. McLaurin, Institute of Paper Chemistry, Appleton, Wis.
Thomas O. Perry, Division of Biology, Erhardt Laboratory, California Institute of Technology, Pasadena, Calif.

The meeting was adjourned at 4:15 p.m.

ROBERT M. ECHOLS, *Secretary*

Fluid Mechanics Committee—Subcommittee on High-Speed Free Surface Flow

The subcommittee met informally at the Mechanics Laboratory, Engineering Research Institute, University of Michigan, at 9:00 a.m., Friday, Jan. 16, 1959. The following members of the TAPPI Fluid Mechanics Committee were present:

Charles A. Lee, R.F.D. 2, Huntingtown Rd., Newtown, Conn.
Girard L. Calehuff, West Virginia Pulp & Paper Co., Covington, Va.
John D. Lyall, Armstrong Cork Co., Lancaster, Pa.
William L. Ingmanson, The Institute of Paper Chemistry, Appleton, Wis.
S. T. Han, The Institute of Paper Chemistry, Appleton, Wis.
Frank R. Forrest, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.
J. D. Parker, Beloit Iron Works, Beloit, Wis.
P. E. Wrist, Mead Corp., Chillicothe, Ohio.
William E. Guthrie, Eastman Kodak Co., Rochester, N. Y.

The University of Michigan representatives present were C. S. Yih and A. C. Spengos.

Later in the day we met two members of the University staff who will have a future interest in the project, William Graebel and W. R. Debler. Absent was Jasper Mardon who was unable to attend due to urgent business and conveyed his apologies.

The present status of TAPPI Research Project No. 140 was reviewed in detail and the program for the new project No. 156 was developed. A. C. Spengos demonstrated the various operations of the model flume and high-speed free surface flow analysis methods to the group. The various problems associated with the operation of the model which had been used to check much of the theoretical analysis was discussed in detail. It was felt that an improved model should be constructed in the immediate future so that much improved experimental information could be obtained. C. S. Yih, with A. C. Spengos assisting, then continued the review of the program related to project No. 140 and the projection into the future of project No. 156. We again reviewed the minutes of the last meeting and compared the status of the project at this time to that of the previous meeting.

Analysis of High Speed Motion Pictures. Dr. Yih and Mr. Spengos spent considerable effort in attempting to use the high-speed motion pictures to define the spouting of the stock on the wire. The motion pictures did give them considerable more understanding of the problem and the difficulties to be encountered in their model analysis. The pictures also provided an empirical means of comparing the model studies with the actual prototype phenomena.

All of the pictures have been returned to the various companies. The committee appreciates the use of the pictures and wishes to thank those companies that provided the movie films.

Review of Model Experiments and Theoretical Analysis. Dr. Yih and Mr. Spengos presented the theoretical analysis for the rate of growth of the disturbance due to downward acceleration. The theoretical analysis deals with the growth of a disturbance as it approaches the crown of the table roll and when it is accelerated downward. The analysis has been substantially completed, and will be reported on in detail at the forthcoming TAPPI meeting in February, 1959. The analysis does point out theoretically there are certain critical wavelengths. These tend to grow more than the wavelengths on either side of the critical. A further refinement of the analysis and experimental confirmation will be carried out under project No. 156.

No theory as yet has been developed for the spouting which occurs subsequent to the downward acceleration phase. The theory of the phenomena is being studied by use of dimensional analysis and two experimental conditions of "wire warp" have furnished preliminary data for the analytical study.

The theoretical analysis of the spiral vortices on the surface of the tube roll when wetted has been completed and certain experimental checks have been made. The results of this phase will be of interest to all technical persons dealing with rolls that are rotating with a thin fluid film on the roll surface. There is substantial mathematical theory involved in the derivation of this work and Dr. Yih has expressed a desire to publish this material in a mathemetical form in the *Journal of the Fluid Mechanics*, a British publication, or in the *Physics of Fluids*, an American publication, subsequent to the publication of the more general paper in *Tappi*. Due credit would of course be given TAPPI. John Lyall consented to present this problem to the necessary TAPPI executives and editors.

The model analysis, i.e., the model check of the theoretical analysis, has been made. A more complete and accurate model analysis is desireable. The future project No. 156 will have, as a part of the program, an improved model over the one presently in use at the University of Michigan.

A qualitative study of the orientation of the fibers within and their relation to the Taylor vortices has been made only in nominal form. The model and equipment had a mechanical failure and is now being repaired. Mr. Spengos had some rather pertinent observations on this matter which will be given further nominal study when the equipment repair has been completed.

Future Program. It was originally intended that, at the conclusion of the model studies and theoretical analysis laid out, a check of the theory using water with fibrous suspension would be made at Peter Wrist's laboratory, Mead Corp., Chillicothe, Ohio. Due to the fact that the analysis and also the model studies have only developed through the downward acceleration phase and have not proceeded into the phase where the spouting action occurs, it was decided that we would delay the Mead Corp. experiments until all of the theoretical analysis and model experiments had been made at Ann Arbor.

The Kimberly-Clark experiments would also be delayed until project No. 156 was developed to a greater extent.

All of the variables outlined in previous committee reports are under study.

Dr. Yih will present a complete report on project No. 140 at the time of the February, 1959, TAPPI annual meeting.

Dr. Yih and Mr. Spengos requested guidance from the committee on the future improved model. Improvements to be incorporated in the new model are (1) longer approach section, (2) better means of producing wave patterns ahead of table roll, (3) variations in table roll or cylinder size, (4) improvements in photographic methods. Should any committee members have thoughts on the above please communicate with Dr. Yih.

The committee members were very much impressed at the quality of the results and progress of the work directed by Dr. Yih and Mr. Spengos. The meeting was adjourned at 4:00 p.m. A buffet luncheon was served by Dr. and Mrs. Yih at their home for the committee members and Dr. Yih's associates.

CHARLES A. LEE, *Chairman*

Graphic Arts Committee—1958 Report

During the annual meeting last year, we announced a reorganization of the committee group which provided for delegation of responsibility in the areas of (1) publicity, (2) technical activities, and (3) papers and programs.

Tom Irwin assumed responsibility for committee publicity activities, W. C. Walker, the technical activities, and Jacqueline Fetsko, the responsibility of operating in the area of papers and programs.

Subcommittee activities have been carried on by the three subcommittees as follows:

1. Surface strength subcommittee has conducted its program in accordance with the research progress report. Please consider that report as part of this one covering that phase of the committee's activities.
2. Printability subcommittee is in the process of reorganizing under the new chairman. Its accomplishments this year have not been outstanding; however, some progress has been made toward the establishment of an acceptable definition of the term, printability, in accordance with a Research and Engineering Council of the Graphic Arts.
3. Ink receptivity subcommittee under W. C. Walker has busied itself with planning a research program in the most important area of the ink receptivity of paper. We will submit a request for research appropriation for this research program in time for consideration at the next meeting of the Research Appropriations Committee.

We have been working with M. C. Rogers, the committee secretary, with the goal of trimming committee membership down to a somewhat smaller, less cumbersome group, made up of more actively interested people. This work will probably be completed in time for a revised committee roster to be published this year.

During the annual meeting in 1958, the Graphic Arts Committee conducted two technical sessions. In addition to the papers presented at the annual meeting, a technical session was sponsored at the testing conference in Savannah during October. This series of papers will be followed by another presentation at the February, 1959, Annual Meeting.

The Graphic Arts Committee is gaining considerable momentum in several areas. We hope for continued support, particularly in the area of research appropriations, since many research jobs of current importance are centered in the graphic arts area, based largely on the paper users continuing an increasing demand for superior paper product performance.

Improvement in the quality of finished printed jobs is rapidly coming to the point where further understanding and improved technology are of paramount importance.

C. A. MORTON, *Chairman*

Optical Properties Committee

The Optical Properties Committee met at 2:15 p.m., Feb. 23, 1959, at the Commodore Hotel, New York City, with 15 members and visitors present. Chairman Van den Akker and Vice-Chairman Hunter were both present. In the absence of a regularly elected secretary, committee member Wiles was asked to act as interim secretary.

Old business as recorded from the minutes of the meeting in Savannah on Oct. 1, 1958, was first considered.

Routine Control Committee. Mr. Wiles was not able to

Optical Properties Committee

attend the meeting next day (Feb. 24) but Mr. Hunter was present and reported.

Graphic Arts Committee. Mr. Wing absent.

Paperboard Testing Committee. Mr. Hudson absent.

Wax Testing Committee. Discontinued.

Joint Advisory Committee on Printing. No meeting since our last meeting.

ASTM-D6. Mr. Silard absent and nothing to report by other members present.

TAGA. Discontinued.

ISCC. Messers. Obenshain and Hunter expect to attend meeting of this Joint Committee in April.

APPA. Representative Obenshain says nothing new to report.

Report of Task Forces

Project 144. Illuminants for Visual Glading and Color Matching. A very lengthy discussion took place on this subject, particularly as regards means for inclusion of the ultraviolet (UV) component in illumination. Representative Lang was asked at the Savannah meeting to review ISCC news and literature and to report periodically to us. It is hoped to make some recommendations soon. A representative of DuPont Pigments Division (Brill) states that they find it necessary to report on dyestuffs and pigments using two kinds of light—outside, McBeth unit with fluorescent component and inside Mazda incandescent—to satisfy themselves and customers.

Mr. Van den Akker suggested that a questionnaire be sent to manufacturers and possibly to consumers asking them, "Under what kind of illumination do you match papers—white and colors?"

Mr. Hunter moved and Mr. Chapman seconded that a task force be set up authorized to submit such a questionnaire at the discretion of the task force to manufacturers, converters, users, those in graphic arts, etc. It was suggested that help might be asked from other committees. The motion was passed and Messers. Lang, Vincent, and Hunter were appointed to this task force.

Project 321. Standardization of 75° Gloss. Will Wink has not been able to complete report on this. Is waiting for data from Bicking. Hunter has preprints of report.

Project 564. Brightness of Paper and Paperboard. Completed, approved, and published in *Tappi.*

Project 565. Opacity of paper completed, approved and publish n *Tappi.*

Project 566. Preparation of Test Method for the Chapman Smoothness Tester. Mr. Obenshain has not had time to complete this.

New Business

Paragraph 1 from October (Savannah) minutes. Does brightness test method need revision to accommodate recent changes made in instrument to accommodate testing of fluorescent dye stuff contribution? Mr. Van den Akker does not believe method needs any major revision. Possibly some minor changes in wording when method next is rewritten.

Mr. Patek (Eastman Kodak) gave brief talk on their experience with the Beckman Model DK-2 in measuring the ultraviolet contribution. A considerable but not expensive modification of the instrument has been made. A 3000° light source is used and all light is diffused so the surface character of the test specimen becomes unimportant. Mr. Patek offered to write a paper relating their experience, to be presented at the fall meeting in Oregon in August if someone could present it. Mr Hunter offered to do this.

Mr. Van den Akker briefly spoke of the Eirepho spectrophotometer, a reflectance photometer made by Carl Zeiss (W. Germany) which is covered in a recent release of the APPA-Instrumentation Program No. 17 Part XII (Jan. 19, 1959). He gave the instrument a very excellent recommendation.

Mr. Lang moved and Mr. Hunter seconded a motion that a task force be set up and a method devised to measure printing ink show-through in paper. A similar motion was passed at Savannah but the acting secretary has no record of such task force having been appointed.

Mr. Hunter moved and Mr. Wiles seconded that a project be set up to see that the TAPPI reference pulp is tested by those optical methods over which we have jurisdiction. It was suggested that perhaps 20 laboratories should participate in order that the data obtained should have statistical value.

It was agreed that a questionnaire be circulated with the minutes of this meeting, asking the members and other interested parties to state what optical tests their laboratories use, which tests need improving and what jobs they think the Optical Properties Committee should tackle. Copy of a similar questionnaire, distributed shortly before the Springfield meeting was given the secretary for revision and inclusion.

The nominating committee—Messers. Wiles, Obenshain, and Vincent gave their report.

Mr. Hunter was nominated for chairman and Mr. Vincent for vice-chairman. These officers were elected. No selection was made for "permanent" secretary. It was suggested that a secretary from the Washington, D. C., area, where the new chairman is located, should be found if at all possible.

The meeting was adjourned at 4:45 p.m.

R. H. Wiles, *Acting Secretary*

Mechanical Pulping Committee—Annual Report

During the past year, the committee spent the major portion of its time on the Third International Mechanical Pulping Conference. This conference was co-sponsored with the Mechanical Pulping Committee of CPPA. The meeting was held in Quebec, Que., Sept. 10–12, 1958, with over 300 delegates and wives attending, including 30 delegates from overseas countries. There were six sessions at which 12 papers were presented and four panel discussions were held. The delegates also had an opportunity to visit eight mills in the area. The Fourth International Mechanical Pulping Conference is tentatively scheduled for the fall of 1961 in Chicago, Ill.

The committee now consists of 21 members. During the past year there have been two resignations and five new members added to the roster. At the annual meeting in February the following officers were elected for the year 1959:

J. K. Kirkpatrick—*chairman*
S. R. Parsons—*1st vice-chairman*
Maung Htoo—*2nd vice-chairman*
J. H. Perry—*secretary*

The officers for the year 1958 were:

A. A. Yankowski—*chairman*
J. K. Kirkpatrick—*1st vice-chairman*
N. F. Robertson—*2nd vice-chairman*
J. H. Perry—*secretary*

The committee sponsored a session at the annual meeting in New York in February, 1959. This session consisted of three papers and a panel discussion.

PROJECTS COMPLETED

Project 593. Glossary. J. H. Perry, *chairman.* This project was completed and is to be included as part of the "Groundwood Manual" project 591.

Project 637. Study of Groundwood Wet Web Strength. Maung Htoo, *chairman.* This project was completed and issued as TAPPI Special Report No. 427.

Project 592. Groundwood Mill Quality Control. A. A. Yankowski, *chairman.* TAPPI Special Report No. 423 was issued and this project was completed.

PROJECTS

The committee will be working on the following projects during the ensuing year:

Project 591. Groundwood Manual. E. H. Johnson, *chairman.* All the manuscripts for the manual are in and are in the process of being edited.

Project 636. Effect of Underwater Storage of Pulpwood on Groundwood Brightness. Several trials of grinding wood stored in piles and under water have been completed and the data is now being assimilated for a report.

Project 678. The Effect of Closed White Water Systems on Groundwood Brightness. F. W. O'Neil, *chairman.* This project received a research grant from TAPPI for $600. Samples are now being obtained from open and closed white water systems for testing at the College of Forestry, State University of New York.

Project 680. A Survey of Groundwood Mill Process Instrumentation. J. K. Kirkpatrick, *chairman.* This project will obtain information on instruments now being used and available and determine the need for additional instrumentation in groundwood mills.

Chip Groundwood Subcommittee. J. H. White, *chairman.* The purpose of this committee is to study the processes of making groundwood by other than conventional methods.

The membership roster of the committee is as follows:

J. K. Kirkpatrick, *chairman,* Bowaters Southern Paper Corp., Calhoun, Tenn.
S. R. Parsons, *1st vice-chairman,* Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis.
Maung Htoo, *2nd vice-chairman,* International Paper Co., Glens Falls, N. Y.
J. H. Perry, *secretary,* Norton Co., Worcester, Mass.
A. A. Yankowski, *liaison officer,* Kimberly-Clark Corp., Neenah, Wis.
N. F. Robertson, West Tacoma Newsprint Co., Steilacoom, Wash.
J. H. White, Keyes Fibre Co., Waterville, Me.
M. S. Anderson, Oxford Paper Co., Rumford, Me.
Piero Bersano, Cartiere Burgo, Piazza Solferino, 11, Cas Post 477, Turin, Italy
F. W. Bishop, Southland Paper Mills, Inc., Lufkin, Tex.
J. P. Corbin, St. Regis Paper Co., Jacksonville, Fla.
Thomas Gerace, St. Regis Paper Co., Sartell, Minn.
Christian Anker, Managing Director, Risor Tremassefabr. Risor, Norway.
Edward M. Jenkens, Johns-Manville Research Center, Manville, N. J.
E. H. Johnson, Stevens & Thompson Paper Co., Greenwich, N. Y.
E. R. Schafer, Forest Products Laboratory, Madison, Wis.
W. H. McPherson, Research Laboratory, Minnesota and Ontario Paper Co., International Falls, Minn.
F. W. O'Neil, State University of New York College of Forestry Syracuse, N. Y.
R. V. Osborn, Great Northern Paper Co., Millinocket, Me.
J. J. Perot, Division of Research, National Gypsum Co., 1650 Military Rd., Buffalo 17, N. Y.
K. E. Pingrey, Diamond Gardner Corp., Ogdensburg, N. Y.

A. A. YANKOWSKI, *Chairman*

Paperboard Testing Committee

A meeting of the TAPPI Paperboard Testing Committee was held in New York at the Hotel Commodore, February 24, 1959.

Members Present

W. O. Kroeshell, Michigan Carton Co.
L. K. Burnett, Ohio Boxboard Co.
W. C. Utschig, General Foods Corp., Carton & Container Div.
W. H. Aiken, Diamond-Gardner Corp.
D. E. Marth, Federal Paperboard Co.
H. W. Verseput, Continental Can Co., Robert Gair Div.

Guests Present

C. E. Brandon, Miami University.
C. M. Swalm, Campbell Soup Co.
D. Ratayski, Thwing-Albert Instrument Co.
E. O. Knapp, Hinde and Dauch Paper Co.
C. G. Eckhart, Ohio Boxboard Co.
E. L. Showalter, Albemarle Paper Manufacturing Co.
L. A. Shipman, Olin Mathieson Corp., Forest Products Div.
A. V. Grundy, Quartermaster Food & Container Institute.

The meeting was called to order at 2:00 p.m. by W. C. Utschig, vice-chairman.

Mullen Test. Mr. Knapp of the Container Testing Committee reported on the proposed standard Mullen test for paperboard including liner board which is ready to submit. The committee voted to cooperate with the Container Testing Committee in sponsorship of this method. This follows the recommendation of the chairman of the Mullen test subcommittee, Mr. DeLong. Copies of the procedure will now be circulated to the committee as well as the Container Committee for consideration.

TAPPI Project 139. Smoothness—Compressibility of Paper and Paperboard as It Relates to Printability. Mr. Verseput, chairman of the joint task committee, reported that the progress report of the status of this project at The Institute of Paper Chemistry was circulated to the committee and that further progress would be reported by Dr. Sears in the Graphic Arts session of the Annual Meeting.

He briefly described the work that has been done with the Van de Akker-Wink apparatus and the improvements in design that have been made, but not evaluated. The

Paperboard Testing Committee

proposal of the Institute to continue and complete this study was outlined. The work will need $12,000 for completion, of which the Institute will furnish $5000, making TAPPI's share $7000.

He then outlined the proposal of the Institute to continue the second phase of the program concerning the dynamic compressibility of paper and paperboard under the conditions encountered in the printing press. This phase will require $15,000, of which the Institute will furnish $5000 with TAPPI's share $10,000. Thus the total of $17,000 will be required to complete both studies.

The recommendation of the joint task committee was to recommend to the TAPPI Research Committee to proceed with the completion of the smoothness studies, but to table the proposal on compressibility until at least the fall meeting.

The committee voted to approve this recommendation of the joint task committee.

Mr. Brandon explained how this project would now be handled under the revised organization of the Testing Committee; that this project would now be the responsibility of the group chairman, Mr. Aiken, who would then conduct a joint meeting of the Paper and Paperboard Testing Committees to consider this project and other projects of joint interest.

Tear Test Subcommittee. Mr. Verseput reported no progress on this project since the paper presented at the Testing Conference. He recommended continuation of the investigating subcommittee and would continue as chairman.

Proposed Test Method. "Stiffness of Paperboard." Mr. Aiken reported that 12 ballots had been received, six giving approval of the method as written and six approving with minor revisions. In addition, the comments of Dr. Clark, as chairman of the Standards Committee, had been received. He suggested that a lettered line diagram of the test instrument be prepared. This has been done. He also suggested that the method detail the number or specimens to be tested.

Mr. Padavic pointed out that there was a "blind spot" of stiffness in the area from 80 to 100 according to the method and requested that a 2-g. weight be provided by the instrument manufacturer to eliminate this "blind spot." Mr. Utschig will write this manufacturer to furnish such a weight and the method will then be submitted as written with respect to this discrepancy.

Mr. Utschig has suggested that the procedure indicate how the instrument is to be stopped at the end point. The procedure was written for the newer instrument which has an automatic brake or for the earlier model with the hand brake. It was agreed to footnote the method with a description of how to read "on the fly" on old instruments without either brake.

Mr. Horita suggested that a method of calibration be included in the procedure. The committee did not want to hold up the method to determine a method of calibration and also the instrument has so little means for getting out of calibration.

The procedure will now be submitted to TAPPI for ballot among the other committees involved.

Representative to the Routine Control Test Committee. Mr. Cassiday reports that he has not received any methods suitable as Routine Control methods, but alkali staining will be submitted by Mr. Utschig.

Representative to Committee for Inter-Laboratory Evaluation of TAPPI Methods. Mr. Utschig had no report.

New Business. The Vanceometer test was discussed. It was decided to write this test as a Routine Control Method, pointing out its limitations. Mr. Kroeschell to head a subcommittee to do this with the help of Mr. Eckhart.

A test for bending properties was tabled pending action by the Boxboard Research and Development Association on its instrument. Now this is being released to the public. It was agreed that the committee should now draw up a standard test method based on this instrument. Mr. Eckhart was appointed chairman of the subcommittee for this project.

A test for the evaluation of scoring was discussed. It was decided to establish an investigative subcommittee to explore this further and make recommendations to the committee. Mr Utschig is to head this subcommittee with the help from Mr. Kroeschell.

Election of Officers. The election of W. C. Utschig of the Carton and Container Division of General Foods Corp., Battle Creek, Mich., as chairman, and W. O. Kroeschell of the Michigan Carton Co., also of Battle Creek, as vice-chairman was made by unanimous voice vote. Donald E. Marth of the Federal Paperboard Co., Morris, Ill., was nominated and elected secretary.

Election is to be held annually at the Testing Conference with no officer to serve more than two consecutive one-year terms.

The meeting was adjourned at 4:00 p.m.

W. O. Kroeschell, *Secretary*

Plastics Laminates Committee

This report has to deal with the activities with Plastics Laminates Committee from Oct. 20, 1958, to Feb. 20, 1959.

A meeting of the Plastics Laminates Committee was held at 9:00 a.m. Oct. 20, 1958, at the Sheraton-Kimball Hotel in Springfield, Mass. There were 33 people in attendance.

It was announced at this meeting that the 14th annual Plastics-Paper Conference would be held at Edgewater Beach Hotel, Chicago, Ill.

A motion was made and carried to adopt membership rules similar to those in force in the Coating Committee. Membership blanks will be printed and distributed to the attending members at the meeting on Feb. 23, 1959.

A discussion followed on proposed additional resin paper tests which the committee might undertake. Uniformity of impregnation, resin solids in paper, and stiffness of impregnated sheet were suggested.

The election of officers for 1959 was held and the following individuals designated and elected:

H. A. Spencer, Knowlton Brothers, *chairman*
C. J. Sieler, Behr Manning, *vice-chairman*
W. E. Morris, Allied Chemical Corp., *secretary*

A report was given by Don Gilmore of the Brown Co. on the round robin testing for the saturability of paper. This is Project 763. At this time, Mr. Gilmore reported that this work was being held up because of incomplete data.

A steering committee meeting was held on January 19 at TAPPI Headquarters. The purpose of this meeting was to develop two new projects and get a number for the project "The Saturability of Saturating Papers."

From this meeting evolved the following: Project No. 763, titled "Tests for Rate of Resin Penetration."

D. M. Gilmore of the Brown Co. is chairman of this project. A round robin test using the William penetrometer has been completed and work is being done on the statistical part for a partial report on February 23 and a complete report being presented as a paper at the fall meeting in Chicago.

Project No. 764. "Resin Solids Test." The object of this project is to develop a test for the determination of resin solids in saturated sheets, uncured, partially cured, and cured. J. Ferguson of the Durez Co. is chairman of this project. To date we have come up with two methods, that are quite similar, to be tried out by Mr. Ferguson's committee. One method being supplied by the Durez Co. and the other method being supplied by Knowlton Brothers.

Project No. 765. "Resin Distribution Test." The project objective is to develop a method for determining the distribution of resin in saturated sheets. C. J. Sieler of the Behr Manning Co. is chairman of this project.

It is hoped that from the three projects we will have three good papers for the Plastics Laminates Committee to give at some future date. It is also hoped that these projects might in turn produce a suggested TAPPI standard.

The committee received from Jack Winchester copies of an ash method for pigment content developed by C. D. Roess, technical director of the Wrenn Paper Co., for NEMA. These copies have been circulated with fairly good response.

H. A. Spencer, *Chairman*

Pulp Purification Committee

The annual meeting of the committee was called to order at 10:00 a.m., Feb. 23, 1959, by Dr. Kraft, chairman, with Vice-Chairman Ferri Casciani and Secretary Don MacLaurin and the following members present:

P. E. Burchfield	L. A. Hiett
Lance H. Crosby	W. W. Northgraves
Foster P. Doane, Jr.	W. H. Rapson
F. M. Ernest	R. J. Solari
F. L. Fennell	L. B. Taylor
A. D. Harbin	J. F. Whalen

H. O. Teeple of TAPPI Headquarters

Dr. Kraft drew attention to the technical session of the Pulp Purification Committee scheduled for 9:00 a.m., Thursday, Feb. 26, 1959, at which time the following papers will be presented:

1. "Physical Properties of Bleached High-Yield Pulps," by N. N. Coe and H. L. Crosby, Dorr-Oliver, Inc., Stamford, Conn.
2. "The Effect of Pulp History on Pulp Response During Hypochlorite Bleaching," by J. C. Paulson, Buckeye Cellulose Corp., Memphis, Tenn.
3. "Oxidation of Some Simple Organic Compounds with Aqueous Chlorine Dioxide Solutions," by R. A. Somsen, Olin Mathieson Chemical Corp., W. Monroe, La.
4. "Pulp Bleaching with Sodium Chlorate," by W. H. Rapson, C. B. Anderson, and R. W. Millen, University of Toronto, Toronto, Ont.
5. "Evaluation of Brightness Changes in High-Yield Pulps Treated with Sodium Borohydride," by P. Luner, Empire State Paper Research Institute, College of Forestry, State University of New York, Syracuse, N. Y.
6. "The Mechanism of the Acidic Chlorination of Lignin," by C. Dence, Empire State Paper Research Institute, College of Forestry, State University of New York, Syracuse, N. Y.

In connection with the meeting, Dr. Rapson noted that he considered the program much too lengthy and strongly recommended that in the future, the Pulp Purification Committee initially schedule two sessions during Paper Week. He pointed out that if necessary it was possible to cancel a session shortly before Paper Week, but it was impossible to schedule an additional session. Dr. Kraft explained the circumstances which led to the placing of six papers on the technical session, but indicated that if reasonable schedule was maintained by the speakers, he expected the session would be concluded within the alloted 3 hr.

Pulp Purification Committee

Dr. Kraft drew attention to Mr. Crosby's suggestion that the annual TAPPI meeting program would better be set up on a time schedule basis, that is, the actual starting time of each paper in each session would be noted in the program. The committee was in agreement with this suggestion, and Dr. Kraft agreed to so recommend to TAPPI Headquarters.

Mr. Crosby's further suggestion that authors of papers should distribute printed copies of graphs and tables rather than using slides and a projector was generally agreed to by the committee, although it was noted that there would be obvious exceptions to such a procedure, as, for example, slides of photomicrographs are not well reproduced by multilith or other common reproduction methods. It was agreed, however, that the suggestion would be conveyed to the Pulp Manufacturing Division.

The committee then dealt with the several items listed in the agenda issued Jan. 20, 1959, as follows:

TAPPI Monograph on Bleaching—Committee Project 642. Dr. Rapson reviewed the status of the revision of the bleaching monograph. He noted that he has considered and planned a revised outline. He further noted that he was extremely busy and that time available for the monograph work was extremely limited. He drew attention to the fact that the bleaching field is in a state of considerable flux, although he anticipated we are approaching a more or less steady state plateau and that perhaps it was well that the revision has been somewhat delayed.

The discussion on the monograph concluded with the understanding that Dr. Rapson would continue as Editor-in-Chief of the revision and that the summer of 1962 is still a possible date for submission of the revised momograph manuscript to TAPPI Headquarters. The committee unanimously agreed to the suggestion that the chairman appoint a subcommittee on the monograph to work together with Dr. Rapson. In connection with the monograph, R. J. Solari made the suggestion that the possibilities of a loose-leaf format be considered. Mr. Teeple expressed the opinion that while there were obvious advantages to a loose-leaf monograph, it would be a distinct departure from usual TAPPI procedures.

TAPPI Research Grant No. 154. For some time our committee has been seeking TAPPI approval of this research project, which deals with "The Preparation of a Critical, Up-to-Date Report Analyzing Information Available in Pulp and Paper Brightness Recession." The project has been approved, and a grant of $3000 has been made to our Committee for this work. The work on this report will commence this May at the University of Toronto. Dr. Rapson has engaged the services of a member of his staff who has adequate mill experience and a second scientific background. It is expected that the report will be completed by September, 1959.

Suggested Pulp Bleaching Conference. The committee was unanimously in favor of a suggestion that a functional conference on pulp bleaching be undertaken by our Pulp Purification Committee. It was noted that the possibility of a joint effort between ourselves and the Dissolving Pulp Committee existed. (At a subsequent meeting, the Dissolving Pulp Committee decided not to participate in a possible functional conference on pulp bleaching.) Tentatively, it was suggested that a target date for the conference would be May, 1960. Mr. Teeple agreed to explore possibilities of location and advise Dr. Kraft of his findings. The possibility of holding the conference in Chicago, possibly at the Edgewater Beach Hotel, was suggested as a suitable central point.

Foster Doane gave the report of the nominating committee, which recommended that the present officers continue for

1959–60. There were no other nominations, and this report was unanimously approved.

D. J. MacLaurin, *Secretary*

Water Committee—1958 Annual Report

The Water Committee meetings were held in New York City during Feb. 16–20, 1958. The Advisory Subcommittee meetings were held on Feb. 16 and 19, and the general meeting of the Water Committee on February 20, in the Hotel Commodore. Two water symposia were presented, one in the morning and one in the afternoon of February 18, in the Palm Terrace of the Hotel Roosevelt.

As a result of the biennial election, new officers were installed in February. The listing of present officers appears in the addenda to this report. A temporary position of "Immediate Past-Chairman" was established, for the purpose of coordinating the task groups of the technical subcommittees, until the new procedures of the reorganized Water Committee are firmly established.

At the close of 1958, the committee membership numbered 52. Membership applications may be obtained from any of the officers.

During the year one task group has been preparing a standard of definitions and terms relating to water. Five task groups are revising T 620 m-55, "Analysis of Industrial Water," and M 400 p-54, "Measuring, Sampling and Analyzing White Waters."

Participation on the panels of the Joint Committee on Uniformity of Water Examination (JCUMWE) is as follows:

JCUMWE panel	*representative TAPPI*	*Assignment status*
Terminology and definitions	Thurn	...
Reporting of results	Thurn & Weidman	Completed
Acidity and alkalinity	None	...
Chemical oxygen demand	McCarthy	...
Dissolved oxygen	Williams	...
Hardness	None	Completed
Solids	Edwards	...
Iron	Hickok	Completed
Grease and oily matter	Dando	...
pH	Barker	...
Organic nitrogen	Fitzgerald	Completed
Uniformity of reagents	Edwards	...
Odor	None	...
Manganese	Lacey	...
Lead	None	...
Chlorides	Slaby	...
Sulphates	Keating	...

As previously described in *Tappi*, the scope of the committee is the review of methods of water examination, published by member organizations, for the purpose of obtaining uniformity in sampling, testing, reporting test data, terminology, and in application. Membership of JCUMWE is limited to nonprofit organizations that (as a part of their functions) prepare, adopt, and publish for general public distribution, water examination methods which are in general use.

Activities of the Subcommittees

Subcommittee I, Advisory. R. B. Martin was appointed chairman of Subcommittee II, Program, in place of J. S. G. Shotwell who was the acting subcommittee chairman. R. A. Dando was appointed chairman of Subcommittee IV, Natural and Potable Water, in place of J. G. Patrick who became vice-chairman of the Water Committee. N. R. Phillips has recently resigned as chairman of Subcommittee V, Industrial Water, and an appointment to fill this position is forthcoming.

Subcommittee II, Program. R. B. Martin, *chairman.* Two symposia were presented at the 1958 Annual Meeting as follows: Symposium I, "Well Field Management." Symposium II, "Purification Capacity of Streams".

Subcommittee III, Definitions and General Specifications. J. G. Weidman, *chairman.* The Task Group for Definitions and Terms has prepared a proposed standard which is ready for letter-ballot vote by members of the Water Committee.

Subcommittee IV, Natural and Potable Water. R. A. Dando, *chairman.* The Task Group on Turbidity has prepared a proposed standard which will soon be presented to the Water Committee for letter-ballot vote.

The Task Group on Iron is nearing the completion of a proposed standard.

The Task Group of Hardness has recently been constituted and is working on a proposed standard.

Subcommittee V, Industrial Water. A. Thurn, *acting chairman.* The Task Group on Solids is preparing a standard.

Subcommittee VI, Industrial Waste Water. V. A. Minch, *chairman.* Because of the recent demise of the chairman of the Task Group on BOD, John J. Priest, the preparation of the proposed standard is temporarily halted.

Scope of the Water Committee

The scope of the Water Committee is the study, distribution of information, and recommendations relating to the demand, application, treatment, and disposal of water in the pulp and paper industry with particular respect to the physical, chemical, and biological properties of influent, internal, and effluent waters in the manufacture of pulp, paper, and paperboard.

Officers

Chairman, J. S. G. Shotwell
Vice-chairman, J. G. Patrick
Immediate Past-Chairman, Arthur Thurn
Secretary, S. K. Adkins
Standards Advisor, B. L. Browning

Subcommittee Chairman

Subcommittee II, Program. R. B. Martin
Subcommittee III, Definitions and General Specifications. J. G. Weidman
Subcommittee IV, Natural and Potable Water. R. A. Dando
Subcommittee V, Industrial Water. A. Thurn (*acting chairman*)
Subcommittee VI, Industrial Waste Water. V. A. Minch

Subcommittee I, Advisory

Subcommittee I consists of the above officers and subcommittee chairman; the chairman of the Industrial Division, William Aiken; and, the members-at-large, C. M. Connor, G. M. Ellis, K. C. Logan, and E. N. Poor.

Subcommittee Personnel

The subcommittee personnel is listed in the 1958–1959 Year Book.

Task Group Personnel

Definitions. B. L. Browning, *chairman.* Members—S. K. Adkins, A. D. Henderson, E. Hickok, K. C. Logan, J. S. G. Shotwell, H. B. Brown, A. Thurn.
Iron. D. W. Miller, *chairman.* Members—P. E. Burchfield, F. J. Slaby, R. J. Baker.
Turbidity. E. R. Gamlin, *chairman.* Members—S. R. Cooper, R. A. Dando, E. N. Poor.
Hardness. S. R. Cooper, *chairman.* Members—R. J. Keating, T. H. Safford, J. S. Kneale.
Solids. E. W. Petrich, *chairman.* Members—C. H. Edwards, A. S. Erspamer, O. F. Hutchinson, J. L. McCarthy.
B.O.D. Chairmanship vacant. Members—F. J. Coogan, H. M. Lacey, A. J. Wiley, R. S. Williams.

John S. G. Shotwell, *Chairman*

Wet Strength and Interfiber Bonding Committee

A meeting of the Wet Strength and Interfiber Bonding Committee was held at the Hotel Commodore, New York, N. Y., on Tuesday, Feb. 24, 1959, at 2:00 p.m.

Present at the meeting were:

K. W. Britt, *chairman* (Scott)

M. L. Cushing (Staley)
M. W. Zembal (Dow Chemical Co.)
R. B. Valley (Eastman Kodak)
J. V. Kindall (Barrett Plaskon)
P. S. Pinkney (DuPont)
J. W. Swanson (I.P.C.)
J. W. Eastes (Scott)
Gerald Keim (Hercules Powder Co.)
A. C. Schmalz (Hercules Powder Co.)
G. E. Thurmond (American Enka Corp.)
P. J. McLaughlin (Rohm & Haas)
E. H. Benz (Scott Testers)
Paul Lagally (Linden Laboratories)
R. E. Millar (Union Bag-Camp)
D. S. Most (Albemarle Paper)
J. C. Pullman (American Cyanamid Co.)
F. J. Kurjan (D. H. Dexter & Sons)
A. H. Nissan (Rensselaer Poly. Inst.)
L. E. Kelley (Rohm & Haas)
H. L. Winslow (American Sisalkraft)
C. S. Maxwell (Cyanamid)

John Swanson reviewed the status of the symposium, "Fundamentals of Fiber Attraction and Bonding," jointly sponsored by our committee and the Fundamental Research Committee. A three-day session (Sept. 9–11, 1959) is scheduled at the Institute of Paper Chemistry, Appleton, Wis. Prospective authors are currently being contracted for the various sessions and it is expected that a complete list of subjects and authors will be ready by April 1. It is also agreed that all abstracts of papers should be submitted by June 1 and the final papers themselves by August 8. Every effort should be made to publish the tentative program for the symposium in the April TAPPI, along with information concerning registration for this meeting.

We have been advised that the local TAPPI section plans a joint dinner meeting open to all registrants at the symposium.

We have been notified that TAPPI Research Grant No. 161 in the amount of $10,000 has been awarded to The Institute of Paper Chemistry. This is a continuation of Research Grant 101 entitled, "Mechanism of Retention of Wet-Strength Resins," on which subject the Institute has already presented two progress reports.

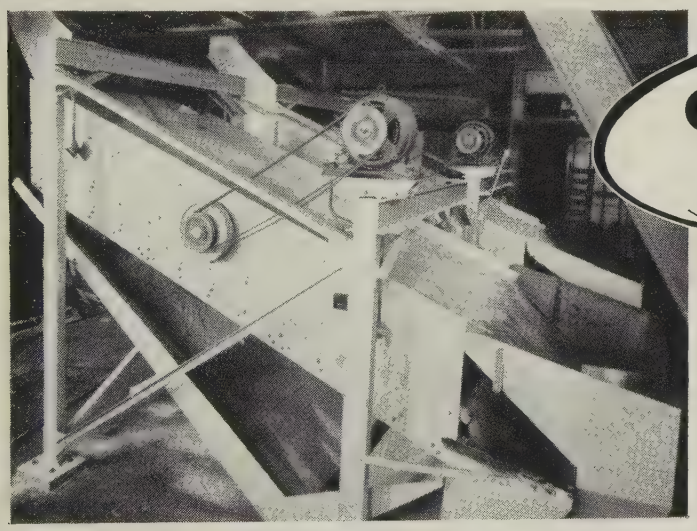
Wet Strength and Interfiber Bonding Committee

John Swanson commented on some of the approaches that the project might follow, in addition to those outlined in the proposal (No. 145). One involved measurement of resin retention in chemically modified cellulose pulp. It was pointed out that this approach would be more time consuming than the others, but was worth considering. Jerry Keim offered to send samples of some modified pulps that Hercules has on hand.

To keep the committee posted on the status of work on this project, John Swanson agreed to submit on a monthly basis, available raw data. The secretary will arrange with Mr. Swanson concerning the number of copies of such data required and the probable issue dates.

It was agreed that the committee would accept the invitation of the Plastics Committee to take part in the 1960 fall plastics meeting at Syracuse, N. Y.

C. S. Maxwell, *Secretary*



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F

Survey of Proof Press Test Methods for Letterpress Printability

WILLARD I. STINGER, FREDERICK C. OPPEN, and KENNETH L. STRACHAN

This report summarizes the current status of paper and paperboard printability testing in the United States. It is based upon an analysis of replies to a questionnaire circulated in August, 1956. The first section comprises a breakdown of replies according to types of industry, and a discussion of the differing needs and objectives of the several types. Then follows a discussion of the physical variables involved in proof press operation, and of the ways in which they have been measured and controlled. The last section is a classification of the actual test procedures according to the way in which they make use of relevant printing variables.

THE establishment of uniform printability test methods for letter press printing is the long term objective of the printability subcommittee whose first formal report is being presented. The lack of correlation of test results between, and even within, organizations has shown the need for some sort of standardization. We must decide, if we can, what printability factors are generally important and what is the best way to evaluate them. We must consider the differing viewpoints of all those to whom printability is important, and seek to recommend the minimum tests that can be expected to serve the greatest majority.

This first report is merely a beginning. It summarizes only the ways in which the proof press is presently used for letterpress printability testing. Obviously we cannot at this time attempt to recommend the best procedure for printability control. This will require a comprehensive evaluation program, probably best delegated to a competent research institution.

The first public act of the printability subcommittee was the circulation, in August, 1956, of a questionnaire which some of you have no doubt seen. This questionnaire requested replies to these four questions:

1. Do you use a proof press for predicting letterpress printability, and if so, what technique is used?
2. What supplementary tests are used, and why?
3. How are proof press results correlated with paper or board properties?
4. How are proof press results correlated with commercial printability?

We sent out 125 questionnaires to representative paper and paperboard manufacturers, converters, ink manufacturers, and research institutions. Fifty-one replies were received including five from mills making no printing grades. We suspect that some of those who did not reply nevertheless maintain adequate printability control programs.

ANALYSIS OF REPLIES

Perhaps the most noteworthy point that emerged from the survey is the way in which the test follow the objectives of the organization. The simplest case would seem to be that of a converter who buys his paper and board. Generally all he wants to know is whether the current lot of stock will print as well as past deliveries that have proved satisfactory. Many times the job itself is the proof. If this isn't enough, relatively simple proof press comparisons may be needed. If he has a large operation, he will face the additional problem of getting several proof presses with different operators to tell the same story. In any case, if there is something really wrong with the stock, his remedy is to ship it back and get new stock. If this fails, he gets a new supplier.

The paper and board mills have a somewhat more complex problem. They must ascertain during production whether their product is going to print satisfactorily. They must find out quickly and take the necessary remedial action at the paper machine if printability is not satisfactory. So a proof press test or any other test is useless unless it tells them what to do on the paper machine before the order has been run out. Postmortems have only academic value. This is why papermakers need quick instrumental tests and are unhappy with the slower proof press tests. Unfortunately, the survey revealed that little progress has been made toward this goal.

The inkmaker has yet another angle. As long as the printer is satisfied with the paper, so, in general, is the inkmaker. His main complaint is apt to be nonuniformity, because he must formulate his inks with sufficient latitude to maintain printing quality gloss, color fidelity, etc., which becomes difficult with nonuniform stock.

Thus we find that the converter, printer, and inkmaker generally use the proof press for direct comparisons, and do not look too far beyond. The paper and board mills, on the other hand, have a compelling interest in breaking the printability test down into its simpler components, capable of being measured instrumentally, and related to the operation of the paper machine and coating equipment.

Table I. Breakdown of Printability Questionnaire Replies

	Type of plant						
	Mfg.	*Mfg. & conv.*	*Conv.*	*Ink mfg.*	*Research*	*Totals*	*%*
Proof press only	2	5	3	2	..	12	26
Proof press physical tests	4	5	3	2	1	15	33
Physical tests only	5	1	..	..	..	6	13
No tests	4	3	6	..	..	13	28
Totals	15	14	12	4	1	46	..
Per cent	33	30	26	9	2	..	100

Table I gives a breakdown of the 46 replies from organizations concerned with printing grades. Note that 13 firms, or 28%, get along without any printability tests whatever. Six firms, or 13%, depend upon physical tests alone. Both proof press and physical tests are used by 15 firms, or 33%, while the proof press alone is used by 12 firms, or 26% of the total. From this we see that 27 firms, or 59%, use the proof press. This indicates considerable confidence in, or at least dependence upon, the proof press despite its known limitations.

WILLARD I. STINGER, supervisor, and FREDERICK C. OPPEN, Senior Scientist, Pulp & Paper Section, Research & Development Div., Marathon, a Division of American Can Co., Rothschild, Wis., and KENNETH L. STRACHAN, R. R. Donnelley and Sons, Chicago, Ill.

CONTROL OF PRINTING VARIABLES

For the purpose of this discussion we can assume that stock approaches printing perfection if it can be acceptably printed at minimum pressure, with a minimum application of suitable ink, and at maximum speed. For an ideal test method then we must know the performance of the printing stock over a practical range of pressure, ink level, and press speed. We must eliminate complications of the test by variations in stock due to uncontrolled humidity and temperature. Let us consider then the means for the control of these variables as they are revealed in the survey replies and in the literature.

CONTROL OF TEMPERATURE AND RELATIVE HUMIDITY

Standard conditions of temperature and relative humidity are used in the physical testing of paper and paperboard because of the wide variation of paper properties with these factors. Since printability depends also on the physical characteristics of the stock, it seems evident that these variables should likewise be controlled for reliable printability testing. Six firms, 13% of those reporting, operate their proof presses at constant temperature and humidity. Much of the dissatisfaction with erratic proof press results may be due to fluctuations in temperature and relative humidity.

CONTROL OF PRINTING IMPRESSION

Impression control is obtained traditionally by caliper measurement of the cylinder packing. The excess of the thickness of packing plus work sheet over the cylinder clearance is reported as thousandths of an inch or points of impression. This is adequate for simple comparisons between cross-backed stocks using the same plate and press. It can cause trouble, however, in more complicated circumstances. The pressure generating effect of a given amount of overpacking will vary depending upon a number of factors. First the tympan and thin sheets used for packing and, of course, the test sheets may be expected to differ in compressibility. The packing will be smashed down an indeterminate amount in service, and will be subject, in unconditioned laboratories, to daily and seasonal humidity variations. Then, with wide forms and heavy packing and the interchangeable use of several proof presses the adjustment and the flexibility of the impression cylinder carriage enters. Somewhere between 0.007 and 0.012 in. impression, the rigidity of the press is exceeded and the cylinder rides the form instead of the rails, which means that the linear relation between packing thickness and pressure is disrupted.

For these reasons, there is a trend toward the use of strain sensitive plate bases so that the actual printing pressure may be measured for each test situation. Probably the first use of such device in this country was by Larocque (*1*) at the New York News Laboratory. The Huck base used by Larocque has a mechanical lever system and has been superseded in some instances by slightly more convenient devices embodying resistance wire strain gages to transduce the pressures. With a strain gage base, the simplest procedure is to determine the deflection with a microammeter under static conditions. Static pressures are about 90% of the corresponding dynamic pressures (*2*) which may be determined with an oscilloscope. This lower value is due to the viscoelastic creep which occurs under static conditions.

The survey showed that four firms (9%) are using this type of device. One firm employs a small commercial press with a built-in pressure control for proofing paper. The IGT and FOGT print testers likewise have built-in spring loaded pressure controls. The consensus among those who have tried this refinement is that tests are much more reproducible when some indicating pressure control is used.

CONTROL OF PRINTING SPEED

It seems just as reasonable that speed ought to be controlled for the best proof press results. The effect of speed upon ink transfer (*3*), and thus upon degree of coverage for a given ink concentration on the plate, has been amply demonstrated. Although speed is controlled in commercial presses and in the more elaborate motor driven proof presses, the widely used Vandercook nos. 4 and 219 are, as most of us know too well, powered with a hand crank. This rudimentary device is probably satisfactory in the simpler testing circumstances, but gives rise to uncertainty in the more complicated situations. A skilled operator might check himself from day to day, although this cannot be proved, but several operators, each with his characteristic strength and reflexes, certainly could not be expected to check each other. One of the first laboratories to attempt to correct this situation was the National Printing Ink Research Institute at Lehigh University. They placed a microswitch (*2*) on the press bed so that it actuated a $^1/_{100}$-sec. electric timer during the passage of the carriage over the form. This was a tremendous improvement, for it enabled technicians to print at a standardized speed and to discard prints which fell inadvertently outside the preselected speed limits. The Research Institute of the Finnish Pulp and Paper Industry uses a 100-cycle pulse generator with a suitable pulse counter to perform the same task (*4*). This degree of control still left something to be desired, so a few years ago, some enterprising technician provided a power drive for the Vandercook. The benefits of a mechanical, predeterminable driving force in place of the hand crank have to be experienced to be appreciated. As yet, only four, or 9% of the firms reporting, use electric timers, and only three, or 7%, have a power drive.

CONTROL OF INKING

It was assumed that everyone who reported using a proof press, metered or controlled the inking in some manner, although not all mentioned this fact specifically. Only two of the firms reported weighing the ink. The rest measure it volumetrically. The most used procedure is to apply a set volume of ink under prescribed conditions, pull a prescribed number of proofs, and then wash up the press. This is adequate for a small volume of testing, but, if many prints must be made, some sort of ink replenishment is generally used, and this introduces complications. The basic assumptions in a replenishment procedure are that the ink is transferred to the paper, without any alteration in the pigment to vehicle ratio, and that the ink does not alter in character on the distributor during the course of the printing. When properly maintained rollers and well-milled, nondrying inks are used, such as the IPI tack graded series, these assumptions appear to be justified. There remains the problem of adding ink at the same rate it is removed in printing, and this involves measuring how much is present on the plate. This was first done in studies of printed solids, by direct weighing of the printing plate (*1*). Indirect methods have subsequently been developed. One is to determine the ink pickup during the printing of plastic film or aluminum foil. Assuming 50% ink transfer, the ink amount on the plate is easily calculated. Another method is to determine the light transmission density of the ink layer printed on transparent film, and obtain the ink amount on the plate from a calibration curve. This requires a suitable densitometer, but it has the advantage that only a small printed solid area is required, which can be incorporated into a screen test plate. Toner extraction techniques are also used. None of the indirect methods require weighing the printing plate. Some check of the rate of replenishment is desirable, as the applied ink is generally not uniformly distributed over the surfaces of the rolls and plate. This idea is catching hold slowly, as shown by the fact that five firms (11%) of those reporting are using a replenishment procedure with an actual check of the resulting ink amount on the plate.

Code	*Classification*	*CTH*[a]	*Press type*	*Plate*	*Pressure control*	*Ink control*	*Speed control*
A	Board mfr. and converter, general packaging	Yes	Vandercook no. 219	5 section—solid and 50% halftone with 4 screen sizes (50, 65, 85, 100)	Each section of solid and 4 tone areas overpacked to different extent. Solid from 0.006 to 0.010-in. steps, halftones from 0.003 to 0.007 in 0.001-in. steps	Ink film thickness adjusted to 0.0030 in. ea. print. Automatic inking. Nondrying black with controlled tack	160 f.p.m. hand operated
B	Paper & board mfr.		Production control—commercial press research proof press Vandercook	Solids and/or 110, 120, 150 and 200-line halftones, depending on test	Overpacking	Vandercook ink control on proof press. Densitometer, weighed plate, and toner extraction techniques	Commercial presses. Speed indicator. Proof press electric stop clock
C	Paper & board mfr.	Yes	Vandercook no. 215	5 × 7 in. magnesium plate (0.153 in.) Weight about 120 g. Solid (no screen)	Maintain standard of 147 lb. per lineal inch of printing contact. Controlled by strain gage measurements of deflection of pressure sensitive plate base	(IPI tack, graded no. 2) Ink applied with stainless screw pipets. Amount varies with job. Replenished with small pipet. Amount determined by weighing plate	180 f.p.m. hand operated. Measured with 1/100 sec. electric timer.
D	Paper & board mfr. & converter, general and food packaging	No	Vandercook no. 4	Solids and 110-line screen tints	By overpacking	Apply constant volume of ink to press distributor. Do not add ink	.....
E	Board mfr. & converter, general packaging	No	Vandercook no. 219, for research only	Solid and halftone grey scales from 85 to 276 lines per in.	By overpacking	Use 0.00025 in. (6.4 mu) for smoother grades. Use 0.00033 in. (8.4 mu) for hard, rough grades	.....
F	Paper & board mfr.	No	M.A.N. Polly Automate, series 50, 14½ × 22 in.	Several plates with solid and screen tints. Fineness of screen depends upon paper under test	Press carries automatic impression control of about 0.0075 in.	Fountain screw adjustment on press. Use special tack-controlled oil-base ink. Get double inking action by printing every other revolution of cylinder	Motor driven press. About 1000 impressions per hour
G	Board mfr. & converter, general packaging	Yes	Vandercook no. 4	Solid, or screen plates, depending on test	By overpacking	Measured with IPI Volumeter	Hand operated approximates production speeds
H	Paper mfr.	No	Vandercook no. 4	Solid, plus 3 screen tints each in 85, 100, 150-line	By overpacking 0.015	No details. Use GPI's no. 5463 proving black	No details
I	Paper and board and converter, general & food packaging	No	Vandercook no. 4 and no. 217	120-line plate with 3 screen tints and solid	By overpacking to 0.006 in.	Use commercial heatset black 1 cc. on no. 4; 1.1 cc. on no. 217	.....
J	Board mfr. and converter, general packaging	No	Vandercook	Several screen tints	.....	.....	.....
K	Board mfr. & converter, general and food packaging	No	Vandercook	Solid—75–50% tints in 85, 100, 110-line screen	75% tint undercut 0.003 in. 50% tint undercut 0.006 in.	Use IPI no. 181-55L-5259 quality control green	.....
L	Paper and board mfr. & converter, general and food packaging	No	Vandercook no. 4	Actual production plates	According to caliper, appearance, and "feel" of board	Actual production inks used in measured amounts	.....
M	Board converter, general packaging	No	Vandercook	Actual production plates	By overpacking and varying plate heights	Actual production inks in measured amounts	.....
N	Board mfr. & converter (has own ink plant), general packaging	No	Potter, hand brayer	Solid and 3 different screen sizes	.....	.....	.....
O	Paper and board mfr. & converter, production control, has own ink plant, general and food packaging	No	Vandercook no. 1 (hand inking) no. 4 (motorized inking)	Solid	By overpacking to 0.012	Use standard blue oil inks. Weigh 1.23 ± 0.01 g. for hand inking. Weigh 5.00 ± 0.01 g. for motorized inking	Moderate and reproducible hand operation

Laboratory printing procedure	*Print evaluation*	*Correlation with commercial*	*Other tests*	*Correlation with paper or board properties*
3 blank prints, then unknown sample printed. Controlled humidity and temperature	Visual determination viewed at 45° angle. Lowest impression for coverage in solid area. Lowest impression for coverage on all 4 screens. Ink absorption by blackness	Good	Pick-tack graded inks on proof press. Ink penetration—Vanceometer	Experience
Commercial—halftones. Research—not given.	Subjective—fidelity of halftone production	Good	Pick-printing gage. Ink setting time—printing gage. Gloss ink performance, ink drying; bond and rub resistance	Experience
Ink clean plate with 4 double passes on "Trip." Remove and weigh plate; make print; reweigh and clean plate. Replenish ink and redistribute. Adjust ink to give 60 mg. ± mg. on plate, which is standard for photo volt evaluation	On basis of ink transfer constants (cf. NPIRI literature) and reflectance (Photovolt Brightness) of prints. Printability = $100\left(\log \frac{\text{Unprinted brightness}}{\text{Printed brightness}}\right) - 25$	Fair	Chapman Smoothness, B & L gloss. I.G.T. Pick test	Fair correlation with Chapman smoothness and B & L gloss
2 inking passes and 1 conditioning print. Make maximum of 8 test prints on one inking of press	Compare test prints visually with prepared series of 5 graded prints. Compare test results with quality of 1-color and 4-color signatures from customers	Limited but useful	Gurley smoothness, Bekk smoothness. Bausch & Lomb gloss	Experience
Make series of proofs at varying impressions	Best halftone reproduction = best smoothness. Determine finest screen not showing dot break up	Satisfactory based on limited experience	Gloss ink holdout from rubber-plate proofs. LTF pick tests	No work done
Make 5 to 10 prints of each side of each stock, using same ink film thickness and makeready. Use natural or accelerated drying	Visual rating for solid and halftone printability	Good, better than with Vandercook press used previously	Gloss, surface strength. Bekk smoothness, ink receptivity, visual smoothness, visual mottle	General effects known by experience, but can't set satisfactory control limits
Several procedures among which are: (a) ink mileage, see *Am. Ink Maker*, Aug. 1957, p. 32.-Alternate standard and test sheets, (b) on solid to determine gloss, or (c) on screen to determine dot formation, etc.	(a) Densichron on successive prints. (b) Photovolt 610 glossmeter. (c) Visual	Good	Pick strength, ply adhesion, wet rub resistance	Insufficient information
Daily printing comparison of samples against standards previously approved by customer. Sample and Standard crossbacked to equalize caliper	Visual judgment of (a) coverage, (b) show-through and strike-through, (c) ink demand by mop-up	By overprinting commercial work	.....	.....
Make 1 conditioning print and discard. Then make four proof prints, on test strips along side standard strips, wash plate, add $1/2$ notch $1/10$ cc. ink, allow ink to distribute, make one conditioning print and discard, then make four prints. Repeat cycle up to four hours before wash-up. Make mop-up as required	Visual evaluation on a 5-step scale from 90-excellent to 50-poor	Experience: production satisfactory if 70% of reels rate 80 or better	Hull-Donnelly red ink smear	No comment
No details	Visual comparison with commercial results	Good	.....	.....
.....	Visual examination for liner or coating pick, smoothness, ability to print over foreign matter on surface, ink penetration and gloss holdout, necessary impression to print, surface uniformity	Good	Production press for check on marginal stocks	.....
No details	Visual	Good, not infallible	Shadow box (formation); black light (coatings); Vanceometer, pick, butyl carbitol drop, weight porosity, stiffness, caliper, smoothness	No comment
No details	Visual and photovolt	Good, but requires improvement	Moisture, finish, brightness, caliper, basis weight, bending qualities, absorption	No comment
No details	Examine plate after printing, for nonuniformity of residual ink pattern. This predicts orange-peel and other unsightly effects, especially in gloss printing	Good	.....	Plate mottle after printing indicates poor stock formation
Mount test strips, with standard on backing sheet, equilizing caliper to 0.001 in. with hard paper underlays. Print successive sheets of mounted samples, redistributing ink between prints, until breakup has occurred on all samples	Visually determine breakup print number and ink lay in relation to standard. Determine ink demand and offset, by double mop-up between plate and last print, using 2-side enameled paper	Good to fair	Bekk smoothness on offset paper grades	No comment

Code	Classification	CTH[a]	Press type	Plate	Pressure control	Ink control	Speed control
O	Research	Yes	Vandercook no. 4	5 × 7 chromed magnesium solid various screens. 1½ × 4 × 0.918 in. pick test blocks	200 lb./lineal inch for board, 300 lb./lineal on paper. Controlled by Westvaco pressure sensitive base overpacked to .008 in.	Measured volumetrically, checked by weighing plate. Measured volumetrically	Press driven by air cylinder, speed measured to 1/100 sec. with electric timer. Range—60 to 320 f.p.m.
P	Paper mfr.	...	Research only	.....	.....	.....	.....
Q	Paper and board mfr.	...	.....	.....	.....	.....	.....
R	Paper mfr.	...	Vandercook	.....	.....	Known amount medium tack ink	.....
S	Board mfr.	...	.....	.....	.....	.....	.....
T	Paper mfr., technical service	Yes	Vandercook no. 215	Solid, 50% and 25% tone, 120-line screen. Type high ±0.0005 in. Size 7 × 5½ in., chrome plated	Total packing plus sample sheet controlled to 0.0425 in. ± 0.0005 in. under 200 p.s.i. pressure on Vandercook plate gage	Use 10 volumeter notches IPI. IPI everyday holdfast. Halftone black	.....
T	Research	Yes	Vandercook no. 215	As above	As above	As above, except metered with the Mead Co.'s fountain (q.v.E)	Hand operated—approximately constant at 165 f.p.m.
U	Paper mfr.	No	No	.....	.....	.....	.....
V	Paper mfr., glassine and greaseproof	No	No	.....	.....	.....	.....
W	Paper mfr.	...	No proof press	.....	.....	.....	.....
X	Board mfg. and converter, general packaging	...	.....	.....	.....	.....	.....
Y	Paper converter, newspaper publishing	Rel. hum. below 45%	Vandercook no. 4 impression cylinder under 0.160 in.	6 × 7 × 0.064 in. Solid Mg or Al. 3 × 7 × 0.65 in. 65-line halftone. 3 × 7 × 0.064 in. solid	Huck base, impression cylinder carries 0.160 in. of "newspaper blanket." Use standard pressures of 60 lb./lineal in. Adjust pressure by shimming under base. Use 15 p.l.i. to show formation defects	Use IPI No. NX-2595. Viscosity 4 to 4½ poises. Adjust to 2.00 g./sq. m. ±0.05 on plate	.....
Z	Paper converter, book and magazine publishing	...	Vandercook no. 4	Precision solid printing plate no packing or spotting under plate	Read from Oscilloscope at impression moment. Varied to suit needs of stock	Regulated at 3 g./sq. m. on plate	Power drive, set to 145 f.p.m.
AA	Paper converter, magazine publishing	...	.....	.....	.....	.....	....
AB	Research institution	...	Vandercook no. 4	Solid type high chromed cast iron, level to within 0.0001 in.	.....	.....	.....
AC	Ink mfr.	...	Vandercook no. 4 split vibrator	Solid nickel type standard Vandercook type-high plate	0.002–0.003 in. pressure	Volumetric	Manual
AD	Ink mfr.	...	Vandercook	Various 0.154 in. high design, as required by test	Equalize by cross-backing. Vary as needed, depending on test objective	IPI Volumeter, equalized by making simultaneous comparisons	Equalize by making simultaneous comparisons
AE	Ink mfr.	...	.....	.....	Adjust as needed to suit stock	By weight	.....
AF	Ink mfr.	...	"Poco" proof press. Also small cylinder press	Various designs	Equalize by comparing only sheets of the same caliper	.....	.....
AG	Paper converter, magazine publishing	...	One-color and four-color presses	Selected for complete tonal range	.....	.....	.....

[a] Press operated in atmosphere of constant temperature and humidity.

Laboratory printing procedure	*Print evaluation*	*Correlation with commercial*	*Other tests*	*Correlation with paper or board properties*
Ink transfer: Controlled print series over range *ca.* 2 to 10 g./sq. m. ink on plate. Paper machine studies: 1.5-2 g./sq. m. and 6–8 g./sq. m. Pick Tests: 12 g./sq. m.	Determine ink transfer and print reflectance (Densichron)	No comment	Bendtsen smoothness, Hull-Lehigh wipe, butyl carbitol drop	Printed reflectance at 2.0 g./sq. m. with Bendtsen Smoothness. % ink transfer at 6–8 g./sq. m. with butyl carbitol drop. Pick resistance vs. coating binder content
.....	.....	.....	Smoothness, opacity, gloss, etc.	.....
.....	.....	Good	Pick, Vanceometer, smoothness, visual inspection of grain and formation	.....
Comparison printing of sample with satisfactory paper	Uniformity, number of copies, show-through, picking	.....	.....	.....
.....	.....	Limited	Vanceometer	.....
Ink spread 4 min., plate inked with 2 double passes on trip. Then 10 prints made with ink rollers down. Press washed up after 10 prints	Last satisfactory sheet before breakup is end point. I.e., if breakup on 8th print, print rating is 70	Good. Established by comparing judging panel decision with printability rating	.....	Statistical correlations obtained in some cases
Adjust system until standard paper prints slightly broken in solid area. Test sheets printed with occasional standards for control. Wash press after 1 hr. printing or after longer than min. stop	Visual rating on basis of coverage. Perfect solids coverage = 80. 90 and 100 ratings mean exceptional print density and halftone resolution	Good. Established by overprinting sample. Signatures of 4-color jobs	Donnelly ink smears, K & N wipe, ink setting time, LTF pick test, printing gage pick test, bond, Bekk smoothness, compressibility, Gurley, oil resistance, ink penetration on resistance	Statistical correlations
.....	.....	.....	Hull-Donnelly red ink wipe test	Good
.....	.....	Good	Tests only ink adhesion	.....
.....	.....	.....	Rely entirely on tests of paper properties. No details given	Satisfactory, based on long trial runs and customer acceptance
Check board in carton plant if copy is new or inks have been changed	Visual	Good. Most interested in gloss ink printing	Board mill control by inclined plane tester, Vanceometer, visual smoothness, Dennison wax pick test	.....
Adjust ink film to 2.00 g. ±0.05 g./sq. m. on plate. Print simultaneously two cross-backed samples	Visual for first judgment. For records, determine reflectance of printed area, corrected to 2.00 g./sq. m. Calculate % printing quality = 100 − $\frac{\text{R print, corrected} \times 100}{\text{R paper}}$	Excellent	Bendtsen smoothness, Hunter reflectometer for show through, brightness and opacity, caliper and basis weight	Shows the effect of basis wt. variations, supercalendering, coating, changes in surface smoothness and formation
Make successive prints under standard conditions, varying only the printing impression	Note minimum impression required for solid print	Good	Hull-Donnelly red wipe, drawdowns, Chapman smoothness, Ingersoll gloss of paper and print, heat stability, show through (rather than opacity), caliper and bulk. Runnability, tensile at fold	.....
a. Research—no details. b. Control—no details.	.....	Good. Engineers follow test stocks through production	Hull wipe, gloss, smoothness	Good. Study variation of printability and other properties across the paper machine to eliminate large machine direction variations
Depends upon objective. Ordinary comparisons by simultaneous printing with cross-backing (Weymouth technique)	.....	.....	.....	.....
Methods of Berberich, *et al.* Object is to test letterpress ink matches on the stock on which they will be used	Visual	Good. Limited to correlating Vandercook with commercial units	K & N penetration, IGT penetration volumeter, inclined plane (oil drop), Gurley, pH of stock	In most cases good, some unexplained exceptions
Depends on objective. See Weymouth, *Paper Trade J.*, April 9, 1942	Visual. Depends upon objective. Comparison with papers of known printing performance	Good	K & N penetration. pH. Hull wipe, Dennison wax, smoothness	.....
Distribute a weighed amount of ink and pull several proofs	Visual—main emphasis is on color match	Good	Inkometer, viscometer, etc.	.....
Make simultaneous prints on poco proof press. Print 30 sheets each, sample and standards, on cylinder press	Visual—check for: setting and drying time, offset, inklay, print sharpness, color, density, finish, chalking and "hardness of dry"	Good	.....	.....
Make proofs on wire and felt sides, one- or four-color, depending on end use	Visual	Useful, not infallible	.....	.....

Table II. Printing Tests Classified According to Use of Ink Level and Impression

	Number firms using
A. Vary impression with constant ink level	4
B. Vary ink level with constant impression	5
C. Vary simultaneously ink level and impression	..
D. Hold constant both ink level and impression	13

CLASSIFICATION OF PRINTING TEST METHODS

Generally, tests are conducted using a single ink and uniform speed. With these limitations, present-day test methods can be classified as in Table II.

A. Varying Impression with Constant Ink Level

Ink level is held substantially constant by limiting the number of prints, by replenishment of the ink, or by a metering device. Impression is varied by means of premakeready, or by changing the packing. In evaluation the best stock gives the most perfect print with the lowest impression. Judgment may be visual (completeness of screen pattern, continuity of solids) or by means of a reflectometer (blackness of solids).

B. Varying Ink Level with Constant Impression

The ink level is varied by depletion over a long series of prints, or on a single print by the use of a tapered groove printing plate (printing gage) (*5*). The best stock gives the most perfect print at the lowest ink level. Tests are usually restricted to solids, and may be judged visually (breakup) or instrumentally (comparative blackness of solids).

C. Simultaneous Variation in Ink Film and Impression

This results from the use of a special test block comprising several tapered ink grooves machined into the surface of a tapered steel block. This device is being privately developed. The best stock gives the most perfect print at the lowest combinations of inking and impression, and may be judged visually or with a reflectometer.

D. Both Ink Level and Impression Held Constant

The ink level is held constant by the means mentioned under A above. The best stock gives the best print, i.e., makes the best use of the available ink and pressure, as compared to others printed under the same conditions. Judgment may be visual or instrumental as under A, and screen and solid test plates may be used. Tests of class D are the most widely used according to the survey. This is undoubtedly because Class D is the oldest and most direct test method, and, in its simplest forms, the easiest to carry out and to interpret.

A new design for screen test plates is gaining acceptance. It removes some of the uncertainties attending visual judgments of printing surfaces. This plate has a range of screen sizes in the same per cent tone, rather than a range of tones in the same screen size. The latter design is used by ink companies for color proofing. It was adopted, perhaps without too much scrutiny, by papermakers and converters when they started printability testing. The alternative design, with a range of screen sizes, appears preferable where the printing surface rather than the ink is to be evaluated. It has been applied to both class A (*6*) and class D tests, and to gravure printability testing (*7*). The prints are evaluated visually on the basis that the best stock is smooth enough to pick up the finest screen dote with minimum impression. Skip counts under low magnification may also be used if desired. Three firms (7%) reported that they are using this type of plate.

This concludes our summary of proof press testing procedures as they are carried out today. Correlations between these tests and paper properties, or commercial printability, could not be derived from the survey results. We realize that such correlations are the essence of a successful printability test method. Although much work is being done in this field, more must still be done, before reasonable agreement can be reached on standard tests.

The printability subcommittee extends thanks to those who have participated in the survey.

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* Only previously published information is cited here, because of the confidential nature of the survey.

Presented at the 43rd Annual Meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 17–20, 1958.

RECENT BOOKS

Operations Research for Industrial Management. By Demitris N. Chorafas. I.B.M. World Trade Corp. Reinhold Publishing Corp., New York, 1958. Cloth, 6 × 9¼, 303 pages. $8.75.

It is expected that the coming generation of managers will use the methods, designated as operations research, as confidently as the last generation used the methods of cost accounting. The advent and growing use of the large-scale computer has made possible the development of more complicated and more realistic models by which the solutions can be obtained on a reasonable time schedule. Consideration is given to the application of operations research to financial allocation, transportation problems, inventory control and production setups. The subject matter is presented as simply as possible so that persons who are not mathematicians will be able to understand the importance of the theories discussed.

Cost Manual for Piping and Mechanical Construction. By Herbert Herkimer. Chemical Publishing Co., New York, 1958. Plastic-spiral loose-leaf, hardboard 6 × 9, 171 pages. $10.

A book of 115 tables, all calculated in man-hours, which enables engineers, plant maintenance managers, and others to pre-estimate, at least roughly, how much a job should cost. The main topics covered include estimating forms, job overhead, job equipment, job expense, competitive bidding, standard production laws, budget estimates, cost-plus-fee estimates, performance factors, erection of steel, alloy and noncorrosive piping, valves, fittings, hangers, screwed, flange and meld construction, process piping, pipe covering, erecting machinery and tanks.

Laminated Plastics. By D. J. Duffin. Continental-Diamond Fibre Corp. Reinhold Publishing Co., New York, 1958. Fabrikond, 5 × 7½, 254 pages. $5.75.

The tenth pocket-size book in the Reinhold Plastic Application Series. It is semitechnical in nature and is addressed primarily to users rather than manufacturers of laminated plastics. Among the subjects covered are the chemistry and properties of resins, base materials and reinforcements, manufacturing processes, grades and characteristics of high-pressure laminates, machining of laminated plastics, and heat-resistant and other special laminates.

Fine Particle Measurement. By Clyde Orr and J. M. Dalla Valle of the Engineering Experiment Station, Georgia Institute of Technology. The Macmillan Co., New York, 1959. Cloth, 5½ × 8¼, 353 pages. $10.50.

A detailed discussion of the important etchniques currently in use in research laboratories for the measurement of size surface and pore volume. More than seventy techniques are described, including automatic scanning, the fixed time method, the Hauser-Lyner method, gravimetric analysis, and liquid phase sorption. A bibliography of four hundred references complements the text.

Work Measurement. By Virgil H. Rotroff. George Elliott Co., Inc. Reinhold Publishing Co., New York, 1959. Fibrecord, 5 × 7½, 203 pages. $4.85.

A book of interest to industrial engineers and practicing managers. During the past few decades the art of time study has evolved into the science of work measurement, providing better and more dependable measures for labor cost control. Among the subjects covered are: how to set work standards, time-study, standard data, how to use work standards, economics of work measurement and work standards dont's.

Paper and Pulp Makers Directory of Sweden, Norway, Denmark and Finland—1958–1959. A/B Hugo Bruse-witz, Goteborg, Sweden. Cloth, 5½ × 8, 355 pages. Price—30 Swedish crowns.

Previous editions of this excellent directory of the Scandinavian pulp and paper industry have been reviewed in these pages. Each mill is described in terms of owners, managing director, sales manager, location, shipping ports, postal address, machinery, annual production and remarks. In addition the general trade rules are presented, trade marks listed and a map shows the location of pulp and paper mills.

Scale-Up in Practice. Edited by Richard Fleming. San Oil Co. Reinhold Publishing Co., New York, 1958. Fabricord, 5 × 7½, 134 pages. $4.50

A practical text based on an "Experience in Industry" symposium jointly sponsored by the Philadelphia-Washington Section of the American Institute of Chemical Engineers and the Unviersity of Pennsylvania in which laboratory achievements were converted into commercial success. Among the subjects covered are: the use of pilot plants in scale-up; scale-up theory and its limitation; analog approaches to scale-up; the business economics of scale-up; and organizing for scale-up.

Welding of Plastics. By J. A. Neumann, American Agile Corp., and Frank J. Bockhoff, Professor of Chemical Engineering, Fenn College. Reinhold Publishing Co., New York, 1959. Fabricord, 6 × 9, 279 pages. $7.25.

A book of considerable assistance to engineers and manufacturers who are interested in the present and potential applications of plastics in the process industries. The pioneers in the field of plastics welding were men experienced principally in the fields of metal welding and metal fabrication. Consequently, many plastic welding techniques are extrusions or modifications of metal welding techniques. Among the subjects covered are hot-gas welding, heated-tool welding, friction welding, ducting and piping, linings. Several useful appendices are given, including glossary of terms, trade names of weldable plastic materials, chemical resistance of some weldable thermoplastics, service ratings of weldable thermoplastics, and service ratings and service temperatures of weldable plastics.

Phillips Paper Trade Directory of the World—1959. Issued by S. C. Phillips & Co., Ltd., Alliance House, 50–51 Fetter Lane, London E.C. 4, England. £2.3.6.

This annual has been mentioned in these reviews for several years for the benefit of Americans planning to travel in Europe and needing to have information about European paper mills. It covers most of the pulp and paper countries in the world.

Inorganic Fibres. By C. Z. Carroll-Porczyuski. Academic Press, Inc., New York, 1958. Cloth, 6 × 9, 352 pages. $11.

Nineteen chapters giving useful information concerning glass fibers, slag wools, rock wools, and asbestos in a large number of their forms and uses. Brief mention is made of cellulose-glass fibered papers.

Statistical Quality Control. By D. H. W. Allen, Metallurgical Statistical Analyst for the American Iron & Steel Institute. Reinhold Publishing Co., New York, 1959. Cloth, 5 × 7½, 129 pages. $3.50.

This pocketbook included in the Management Science Series is an introduction to the subject of statistical quality control for the benefit of management. It is one of the simplest explanations of the subject and quite devoid of mathematical details of the technique. Persons engaged in statistical quality control need to be familiar with the mathematical complexities of the subject. It is important, however, for management to have an appreciation of it so that those persons engaged will have the necessary support and incentive to make use of the techniques for the benefit of his employer.

EMPLOYMENT SERVICE

POSITIONS WANTED

E466-59 Chemical Engineer, presently employed, BS in Chemistry and Chemical Engineering. Ten years experience in mill technical control, trouble shooting, coating formulation, size press film coating, and print quality evaluation. Knows how to make quality fine papers at lower costs. Desires challenging position in P & D, or production with a fine paper mill or a chemical company serving the paper industry. Résumé and references upon request.

E467-59 *Packaging Engineer*—experience includes manufacture and design of corrugated and folding paperboard products—some experience with other media. Strong on practical aspects of packaging—design, testing, specifications. Installed testing lab. and developed testing techniques. Considerable experience in customer contacts and in working with Sales. Age 37. College graduate, BA, MA. Would like to discuss qualifications with company offering opportunity to advance. Currently employed. Prefer southern or far western location.

E468-59 Man with extensive experience in technical and production phases of wide variety of papers, research technical and production supervision work in hard sized as well as low density absorbent specialties. Desires position where there is latitude for application of personal efforts and experience in any of those phases of the industry.

POSITIONS OPEN

WANTED

Chemical Engineer or Chemist with paper experience for applications and technical sales work with company selling adhesives to the coated paper trade. Excellent position with well-established company; located Middle West. Pleast send full résumé to P833-59, Tappi, 55 East 44th St., New York 17, N. Y.

P836-59 Plant Engineer: For maintenance and plant lay-out in a two-machine mill, located in the Mid-East. Five years experienced in cylinder machine and specialty mill experience required. CE or ME degree preferred. Old established company, all fringe benefits and liberal starting salary.

P841-59 Production Manager: For a Mid-East specialty mill to understudy assistant General Manager. Excellent opportunity for the right man to get in on the ground floor. A graduate engineer of a Pulp and Paper Technology preferred, although a CE degree will suffice. Experienced on cylinder machines with latex fiber preferred. A pleasing personality with the ability to organize and maintain his own department is necessary. All fringe benefits, salary commensurate with experience. Regular increases. All replies held in strictest confidence.

ASSISTANT EDITOR

Young man with at least three years experience in the pulp and paper industry and ability to write well wanted to work on the staff of **Tappi,** the monthly magazine of the Technical Association. Applicants please send complete résumé of education and experience to **Tappi,** 155 East 44th St., New York 17, N. Y.

(P842-59)

P843-59 Wanted—Paper Chemist. Good opportunity with expanding chemical manufacturer in southeastern United States. Should have several years experience in the paper industry, including coating.

P844-59 *Sales Application Engineer Wanted* for Sales Department of converting machinery builder in New York State. Prefer mechanical engineering background. Varied, interesting, and growing product line in paper, film, and foil machinery. Offers excellent growth opportunity.

TECHNICAL DIRECTOR

(Multi-Plant Responsibility)

For manufacturers of highly specialized papers, affiliated with a very large consumer goods corporation.

Able to initiate development programs and to establish mill technical programs and procedures.

Training and experience equivalent to the doctorate in chemistry or chemical engineering required.

Main office in Mid-Atlantic area.

Send complete résumé to P845-59, Tappi, 155 East 44th St., New York 17, N. Y.

P846-59 Chemist or Chemical Engineer with experience in the manufacture or converting of paper. Should have interest in new areas for the use of petroleum products. Major oil company, Metrolpolitan New York.

P847-59 Help wanted. Cellulose research chemist, MS or BS, with education or experience in field of pulp, paper, or cellulose derivatives. Rush details of education, experience and personal data together with recent photograph to Personnel Director, Southern Chemical Cotton Co., Alton Park, Chattanooga 10, Tenn.

P848-59 Exceptional opportunity for board mill supervisor in new insulating board plant located in north central states. Must be thoroughly versed in operation of defibrators, disk refiners and fourdrinier board forming machine. Give full particulars in first letter. All information received will be confidential."

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Midwestern paperboard and folding carton manufacturer has challenging opportunity for outstanding graduate EE with industrial experience in both power and electronics (industrial controls). Age 30–35 preferred. Excellent salary and fringe benefits including profit sharing. All replies confidential. Reply to P849-59, Tappi, 155 East 44th St., New York 17, N. Y.

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Graduate Chemist or Chemical Engineer with experience in preparation, formulation and use of coatings for food board and carton grades is required by our Technical Division. Send résumé of experience to

Employment Manager
Camp Division
UNION BAG-CAMP PAPER CORPORATION
Franklin, Virginia

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Research and Development Department needs young PhD or equivalent to become nucleus of new group. Excellent growth potential. Company has four mills producing saturated papers and high quality bond and ledger paper. These mills are completely integrated with digestion, stock preparation and paper manufacturing. The company has other plants producing industrial materials which relate closely to its paper products.

The modern research facilities of the business were built only 5 years ago with a pilot plant and provision and building space to double its present activities. Outstanding opportunity with a growth company. Please send complete résumé including present salary to:

MANAGER OF INDUSTRIAL RELATIONS
NATIONAL VULCANIZED FIBRE CO.
WILMINGTON, DELAWARE

(P851-59)

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Our expanding Technical Sales Service Department offers an exceptional opportunity for a technically trained man with 5–10 years of experience in corrugating and/or paper manufacturing and converting fields. This challenging position concerns the handling of matters relating to the use of starch products in industrial applications. Excellent insurance and retirement programs. Extensive travel necessary.

Please send résumé with details of education, experience, and salary requirements to:

TECHNICAL SALES SERVICE DEPARTMENT
CLINTON CORN PROCESSING COMPANY
CLINTON, IOWA

(P852-59)

P853-59 Opening Available for young man in association work with background in paper or board manufacture. Must have good personality and sound judgment. Some traveling required. New York office. Good opportunity for advancement.

ROUTINE CONTROL METHODS

RC-271. Iron in Cellulosic Materials Colorimetric Method

Significance of Test. Iron is an impurity which impairs color or may act as a catalyst to cause harmful chemical reactions. The iron content of cellulose, cellulose acetate, and other materials used in the manufacture of cellulose acetate should be low.

In this method a weighed specimen is ashed. The ash is then dissolved in dilute hydrochloric acid and the iron is determined colorimetrically in the solution by the thiocyanate method.

The determination of minute amounts of iron is not a simple task. Exercise extreme care in the handling of samples to avoid gross contamination such as rust from iron ring stands, light fixtures, pipes, and many other things common to the laboratory. Make sure that all dishes and other apparatus are clean and that all reagents are as nearly iron-free as possible. Always run blanks. Keep samples covered as much as possible; never leave them uncovered while unattended.

Apparatus. Muffle furnace, 575 ± 25°C.; dish, Vitreosil, silica, porcelain, or platinum, 75–100 ml. or crucible, Coors porcelain, wide form, no. 3; funnel, glass, 35 mm., short stem; funnel rack; filter paper, 7 cm., Whatman no. 1; Nessler tubes, 50 ml., tall form, scale length 200–250, *matched set*—the graduated scales should not vary more than 1.5 mm. in height in a set of tubes; color tube support for 12 APHA Standard Tubes; cylinder, graduated, 50 ml.; pipets—1, 2, 5, 10 ml., respectively; buret, automatic, Pyrex, 5 ml.; rubber stoppers to fit Nessler tubes; flask, volumetric, 50 ml.; colorimeter or spectrophotometer with 1-cm. cells.

Reagents. Acid, hydrochloric, HCl, dilute 1:1; iron solution, Fe^{+++}, standard, 0.0001 g. per ml.; potassium thiocyanate, KCNS, 10%; ammonium persulphate, $(NH_4)_2S_2O_8$, solution, 2 g. in 20 ml. of solution—make up each day at beginning of analysis and discard any remaining at the end of the day.

Test Specimen. Obtain a sample of pulp weighing at least 25 g. which is representative of the entire lot being tested. If in sheet form, tear it into small pieces and mix the pieces thoroughly.

Procedure. Weigh a 10.0 ± 0.1 g. specimen of the oven-dry pulp and transfer it to a 100-ml. silica, porcelain, or platinum dish.

Adjust the sample weight according to the amount of iron expected. A perceptible color should develop with the reagent; but the color should not be so intense that differences cannot be detected.

Place the dish containing the sample over a gas burner and heat gently until the material is well charred. Transfer to a muffle furnace at 575 ± 25°C. until all the carbon is burned off as shown by the absence of black or glowing specks (10 to 15 min.). Alternatively, place the dish directly in the furnace and heat for 30 min. or until all the carbon is burned off.

Remove the dish from the furnace, place it on an asbestos mat, cover it with a platinum or aluminum cover, and allow it to cool. *Exercise extreme care that the ash is not blown away while the dish is being transferred from the muffle to the work bench.*

Solution of the Residue. Slide the cover of the dish aside and wash down the sides of the dish with 10 ml. of 1:1 HCl, dispensed from a pipet.

Remove the cover and heat gently on the hot plate to dissolve the ash. When all the ash has been dissolved, boil gently, avoiding spattering, until the volume is reduced to 4 or 5 ml. Remove the dish from the hot plate and allow it to cool to room temperature.

Extreme cleanliness is essential. Clean all apparatus with dilute hydrochloric acid and rinse prior to use.

Transfer the solution containing the iron to a 50-ml. Nessler tube. Rinse the dish three times with 5 to 7-ml. portions of distilled water and add the rinsings to the Nessler tube. Add 1 ml. of 10% $(NH_4)_2S_2O_8$ solution to make the solution about 0.02 *M* in this reagent, to oxidize the iron present, and to stabilize the thiocyanate color.*

To the Nessler tube add, from a graduate, 5 ml. of 10% KCNS and dilute to about 50 ml. with water. Mix thoroughly and place in a viewing rack.

To another Nessler tube, add, from a graduate, 5 ml. of 10% potassium thiocyanate, 10 ml. 1:1 HCl, 1 ml. $(NH_4)_2S_2O_8$ solution, and dilute to about 45 ml. with water. Stopper and invert the tube three times to mix.

If any perceptible color is seen at this point, the reagents, particularly the acid, may be contaminated. If a recheck with carefully cleaned apparatus confirms that the reagents are contaminated, discard them and repeat the whole analysis with fresh reagents. Add, from a 5-ml. buret, small portions of standard iron solution. Stopper and mix thoroughly after each addition and compare with the sample tube in the viewing rack. Continue the additions until the colors in the two tubes are the same when viewed in a good light.

If the reagents have not been used recently, check them as described above before beginning the analysis to avoid the possibility of repeating the entire procedure with fresh reagents.

When several samples are run together, one titration will serve by starting comparisons with the sample tubes arranged in order of increasing color. For large numbers of samples a series of standards covering the expected range can be made and used, up to within two hours, without excessive fading.

Calculations. One milliliter standard iron solution contains 0.0001 g. of iron. S = sample weight in grams; T = milliliters of iron solution used.

$$\text{Iron, p.p.m.} = \frac{T \times 0.0001 \times 10^6}{S} = \frac{100T}{S}$$

When S = 10.0 g., p.p.m. iron = $10T$. When S = 10.0 g., report iron to the nearest whole p.p.m. When S is greater than 10, calculate and report to the nearest 0.1 ppm.

Examples. Weight of sample, 10.0 g.; volume of standard iron required, 1.11 ml.

$$\text{Iron, p.p.m.} = \frac{1.11 \times 0.0001 \times 10^6}{10} = 11.1 \text{ p.p.m.}$$

or $10T$; $1.11 \times 10 = 11.1$ p.p.m. Report as p.p.m. iron.

This is a Routine Control Method and should not be considered as a Standard in any way. Corrections may be made before loose-leaf publication. Comments will be welcome and should be sent to A. J. Winchester, TAPPI, 155 E. 44th St., New York 17, N. Y.

RC-270. Film Identity Tests

The purpose of this method is to identify quickly the various films used in packaging.

* Sandell, "Colorimetric Determination of Traces of Metals," Second Edition, Interscience, 1950, page 368.

Film Identification Chart

Material	Halogen test: Tear test	Halogen test: Copper wire in flame	Burning tests: Odor	Burning tests: Rate	Solubility tests: Water	Solubility tests: Hot toluene	Solubility tests: Methyl alcohol	Solubility tests: Ethyl ether	Solubility tests: Acetone	Approx. melting point
Regenerated cellulose (cellophane)	Uncoated	Easy to tear	No reaction	Like paper	Cellophane does not melt, drip, or form beads. Burns same as paper. Continues to burn when withdrawn from flame	Wets and swells	I	I	I	Chars
	Nitrocellulose coated	Easy to tear	No reaction	Like paper	Same as paper; continues to burn when withdrawn from flame	No effect	I	I	Coating soluble	Chars
	Flameproof	Easy to tear	No reaction	Acrid, paper	Won't burn; chars	Does not dissolve	I	I	Coating soluble	Chars
	Saran coated	Easy to tear	Green color to flame (from coat)	Like paper	Same as paper; continues to burn when withdrawn from flame	No effect	I	I	Coating soluble	Chars
Cellulose acetate		Easy to tear	No reaction	Mixture of acetic and burning paper	Burns slowly when removed from flame. Beads at edges of burnt area	I	I	Sl.S.	I	S	Rigid Types 230–245°C. Flexible Types 200–215°C.
Ethyl cellulose		Easy to tear	No reaction	Sweetish	Fairly rapid	I	S	S	Sl.S.	S	
Cellulose acetate butyrate		Easy to tear but tougher than cellulose acetate	No reaction	Rancid butter	Similar to cellulose acetate	I	I	.	I	S	180–185°C.
Polystyrene		Easy to tear	No reaction	Like Marigolds	Melts into clear liquid	I	S	I	S	Becomes very soft	190° Approx.
Rubber hydrochloride		Hard to tear	Green flame	Rubbery	Moderate rate; green edge to flame. If tensilized, heat shrinks film	I	S	I	I	I	100°–108°C.
Vinyl chloride		Hard to tear	Green flame	Pungent, irritating	Extinguishes itself when removed from flame	I	I	I	I	I	160°–165°C.
Polyvinylidene chloride		Hard to tear	Green flame	Pungent, resin mixture	Extinguishes itself when removed from flame; shrinks	I	I	I	I	I	140°–145°C.
Polyethylene		Hard to tear	No reaction	Like burning candle wax	Fairly rapid; melts and drips like wax	I	S	I	I	I	107°–112°C.
Polyvinyl alcohol		Hard to tear	No reaction	Soapy	Moderate	S. in hot water	I	I	I	I	
Nylon		Hard to tear	No reaction	Like burning hair	Blue edge to flame; extinguishes itself when removed from flame	I	I (Soluble in phenol)	I	I	I	230°C. softens

I = Insoluble; S = Soluble; Sl.S. = Slightly Soluble; Coat. = Coating.

Samples of known films are helpful for comparison.

The following outline details the steps to take and the chart on the following page lists the test characteristics of the various films:

I. Using scissors, cut 1/2 in. into the film from the edge. Extend this tear by a hand pull and then classify the film as being either "easy to tear" or "hard to tear."

II. If "Easy to Tear":

A. Ignite a small piece, 1 by 2 in., held with tongs or tweezers.

B. Observe the rate of burning and whether burning continues after the sampleis removed from the flame.

C. Blow out flame and immediately smell the burnt sample.

D. By referring to the chart on the next page, you should be able to catalog the type of film by nature of its burnt odor.

E. If the sample is cellophane:

1. Touch film to the tongue:
   a. Uncoated films stick to the tongue and wet readily with water.
   b. Uncoated flame retardant films have a sharp acid taste in addition to sticking to the tongue.
2. If film does not stick to the tongue, it is coated.
   a. Check for heat-seal property, using a bag closing machine or a hand sealing iron, and then separate the seal you have just made. You will find that heat seal: ing films will resist separation.
   b. Soak a piece of the sample film in water. Hot water accelerates the time required to slough nonanchored coatings. Two to three minutes

in boiling water will slough these coatings. Anchored or bonded coatings develop blisters and feel rough after being immersed in boiling water, but coatings remain intact.

c. If film is anchored and heat sealable, make a copper wire test. This is done by heating one end of a 6- to 8-in. piece of copper wire in a gas flame. Drag the hot wire across the surface of the film, then put wire back in the flame. Green color to flame indicates Saran type coating. Nitrocellulose coatings give a dark blue color reaction with a drop of diphenyl benzidine solution ($^1/_4$ gram in 50 ml. of concentrated sulpuric acid).

3. The difference between moistureproof and less poistureproof films cannot be detected quickly. Wrapping individual slices of bread in know moistureproof film, know less moistureproof film and in the unknown film is suggested. After two or three days, compare the hardness of the bread by feeling. Then decide which pattern the unknown film follows.
4. Be sure to determine whether both sides of the test film are coated.

III. If the film is "Hard to Tear":
- A. Follow steps IIA, IIB, IIC, and IID as indicated earlier.
- B. By checking the table, you should be able to classify the films by the characteristic odor.
- C. There is no positive non-chemical test to differentiate between vinyl and polyvinylidene chloride films. The latter may have a floral odor.
- D. Use the copper wire test on all hard-to-tear films. It helps classify them. If gas flame is not available, buy a can of "Sterno" (canned heat). This will work, too, but longer time is needed to heat the copper wire.

IV. When solvents or controlled temperature hot plates are available, solubility and melting point tests will assist in confirmation of film type.

Reference

Blair, C. L., *Paper, Film and Foil Conv.* 31, No. 4: 26–27 (April, 1957.

Contributed by C. L. Blair, Film Dept., E. I. du Pont de Nemours & Co.

This is a Routine Control Method and should not be considered as a Standard in any way. Corrections may be made before loose-leaf publication. Comments will be welcome and should be sent to A. J. Winchester, TAPPI, 155 E. 44th St., New York 17, N. Y.

RC 272. Test for Bonding Strength of Adhesives on Flexible Adherends

The object of this method is to measure qualitatively or quantitatively the bonding strength of adhesives on flexible adherends.

Apparatus. Clipboard; sheet of plate glass which will fit onto clip board; device for drawing down a smooth, even film of adhesive; Bird applicator and metallic foil or paper stencil used in conjunction with a smooth, stiff, cylindrical rod (glass, metal, plastic, etc.); tensile tester (if quantitative results are required).

Discussion. Bonding strength on many flexible adherends can be satisfactorily evaluated with simple paste-up procedures. In many instances the comparative strengths of different adhesives can be semiquantitatively evaluated by pulling apart paste-ups by hand. This is particularly true on paper stocks where a person is usually more concerned with obtaining a fiber-tearing bond than he is with the bond strength expressed in p.s.i. With nonfibrous

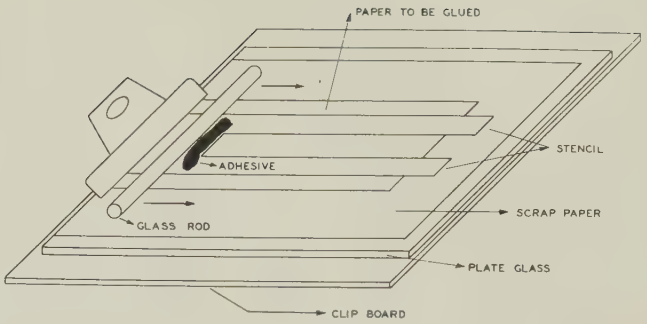

Fig. 1

adherends such as cellophane, plastic films, foils, etc., or with extremely hard-fibered or treated paper stocks where fiber tear is not achieved, it may be desirable to test the paste-ups in equipment which will quantitatively measure bond strength even though semiquantitative results may be obtained by hand pulling. Quantitative measuring is usually desirable when bond strengths are low—either because of difficulty in bonding adherends or because the adhesive is weakened by exposing the bond to some stringent test conditions such as water immersion, high temperature, cold, etc.

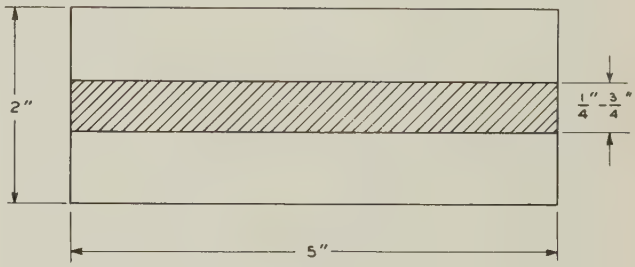

Fig. 2

Procedure. For quick screening tests the adhesive seam may be applied as a bead or ribbon of adhesive with the end of a paper clip or with a small diameter wooden stick or glass rod and then squeezed between the adherends to approximately the desired thickness. For more accurate comparisons the adhesive film should be deposited by a means which insures the same thickness and width (particularly thickness) each time. This can be done with a film applicator such as the Bird, with a stencil cut from shim brass or even with a stencil cut from paper.

It is necessary to have good working surface to draw down consistent adhesive films. Whether working with a Bird applicator or with stencils, a smooth, clean, polished, rigid

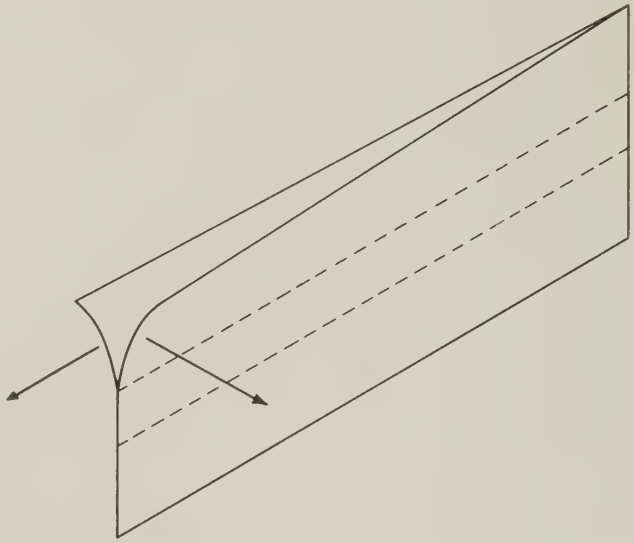

Fig. 3

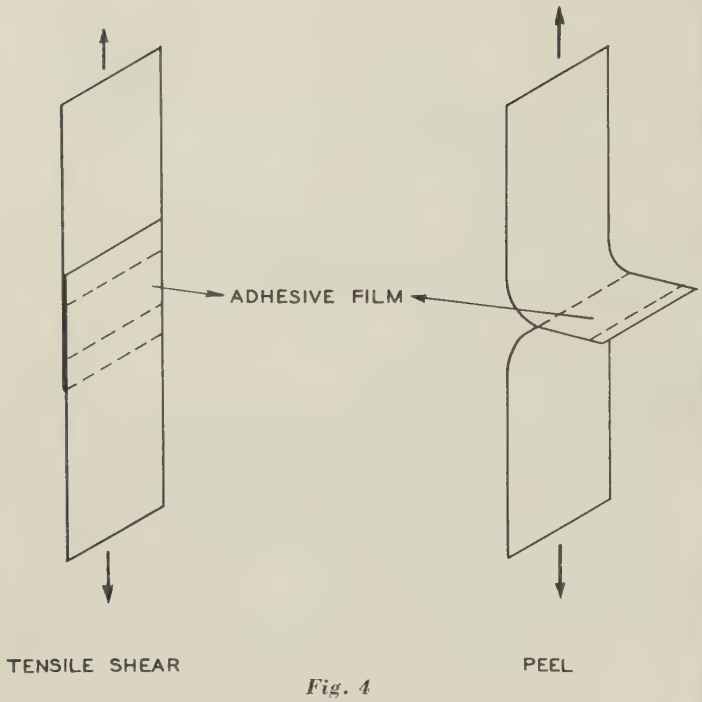

Fig. 4

surface such as plate glass is required for good results. This can be covered with a sheet of scrap paper while drawing down to avoid constant clean up of the glass plate.

The use of stencils for depositing adhesive films involves drawing a smooth, stiff, cylindrical rod (glass, metal, plastics, etc.) over the stencil placed in contact with the material to be glued. An excess of adhesive in front of the rod is deposited through the cut-out area of the stencil as a smooth, even film (see Fig. 1).

An adhesive film in the range of $^1/_4$ to $^3/_4$ in. wide is applied to a strip of one adherend approximately 5 in. long by 2 in. wide (see Fig. 2). These are only suggested dimensions and are not critical. The other adherend, cut to the same size, is then placed over the wet adhesive film, pressed down lightly by hand, finger, rubber roller, block, etc., and the paste-up allowed to dry before evaluating bond strength. Particularly during the humid summer months it is a good practice to dry paste-ups of aqueous adhesives in a low humidity chamber to insure accurate results. After drying the paste-up can be exposed either to existing conditions of temperature and humidity or to some other test condition prior to and/or while checking bond strength.

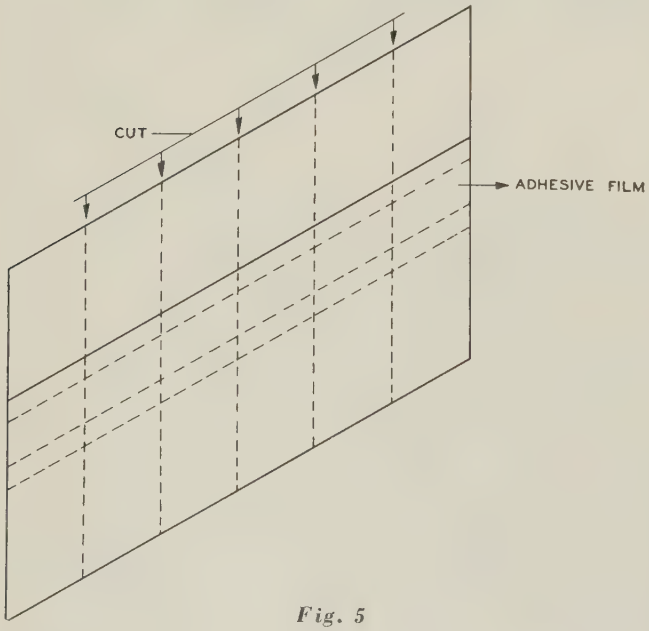

Fig. 5

To pull by hand the adherends are held between the thumbs and forefingers of the hands and pulled or peeled per Fig. 3.

If the fiber tear is initiated at one point, the fingers can be moved to another point for a recheck. If fiber tear once starts, it may continue over areas of poor adhesion, giving a false impression of the true bonding efficiency. By starting to separate the adherends at several fresh points, it is possible to try various angles and rates of separation and peel and thus obtain a more realistic evaluation.

Paste-ups to be tested in tensile machines, static load tests, etc., can be made in similar manner (different dimensions may be required) except that the adherends should be put together to form tabs which may be held in the grips of the machines without trimming (see Fig. 4).

Specimens for tensile machines and static load tests usually have a width of 1 to 2 ins., and the width is specified in any given test. Although these may be made individually, it is quicker and easier to make a larger specimen and then cut it into several of the desired width (see Fig. 5).

It is obvious that the same glue film dimensions must be used in any given test if the dial readings of the machine are to be used as a direct comparison of bonding strength.

Tensile testers such as the Dillon, Instron, Suter, etc., or even spring gages pulled by hand have been used satisfactorily. Sometimes a particular machine may require a new set of lightweight grips to be suitable for testing low levels of bonding strength. Also, if the dial readings are not sufficiently accurate at low loads, it may be necessary to introduce a spring gage into the system.

Source: W. Sederlund, *National Starch Products, Inc. Plainfield, N. J.*

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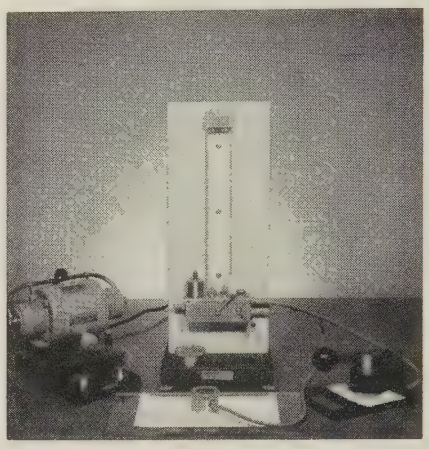

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LOCAL SECTION ACTIVITIES

Reports of Meetings, Personnel, and Events

Ohio

The Ohio Section of TAPPI, with over 200 members and guests in attendance, enjoyed hearing Wilfred Gallay of the E. B. Eddy Co., who spoke to the group on February 10. Dr. Gallay, at present the director of research, spoke on the topic "The Development of Strength in Paper."

The speaker elaborated on four main points relative to acquiring satisfactory strength: (1) strength of fibers, (2) toughness of fibers, (3) interweaving of fibers, and (4) bonding of fibers.

These points were assembled into a unified concept of the development of strength from the headbox of the paper machine to the reel, dealing particularly with theories of bonding and interweaving of fibers.

Bill Friend of Diamond-Gardner Corp. acted as program chairman for the evening.

March Meeting

The March meeting of the Ohio Section of TAPPI was held at the Chillicothe Elks Club in Chillicothe, Ohio on March 12, 1959. A. T. Tseng of the Diamond-Gardner Corp. presented a challenging talk on "Memo-Motion Study and its Applications."

Mr. Tseng received his Industrial Engineering Degree from Chaio-Tung University, Shanghai, China and his M.S. Degree from Purdue University. At the present time he is director of industrial engineering, Gardner Division.

The speaker elaborated on new techniques using motion pictures to record mill operations at prefixed intervals. Memo-motion was originated and developed by Dr. M. E. Mundel in 1945 at Purdue University. The basic advantages of memo-motion, as related by the speaker, are:

1. It provides a more accurate record than visual means for analysis and future appraisal.
2. It provides an effective means for correlating multiple personnel and machine activities for analysis.
3. It facilitates the focusing of attention on major movements needing improvement.
4. It permits assembly of factual data at a fraction of the cost of using regular motion picture speeds covering the same period of study.

Further enlarging upon momo-motion study, Mr. Tseng related the areas of application which are: (1) long cycle operations, (2) irregular cycle operations, (3) man and machine operations, (4) multi-man operations, (5) multi-machine operations, (6) plant layout, (7) ratio delay studies, and (8) irregular occurrence in a normal operation.

The April 14 meeting of Ohio TAPPI will be held at the American Legion Hall in Middletown. This meeting will feature E. Sterling Skinner of the Beloit Iron Works who will speak on the "Inverformer-Multiply Wire Former."

FRANK L. CESSNA, *Recording Secretary*

Indiana District

The Indiana District of the Ohio Section met at the Moose Hall in Hartford City, Ind. on February 17, 1959 and was preceded by a tour of the plant facilities of the Hartford City Paper Co.

Approximately 55 members and guests were present. E. W. Petrich, chariman of the Ohio Section, was among the guests present.

The minutes of the January 20 meeting were read and approved. The treasurer's report showing a current balance of $264.67 was submitted.

The report of the Education Committee was submitted and this schedule includes a talk by Mr. Balfour of this District before the student chapter of the American Chemistry Society in Louisville, Ky. on March 5, 1959. This district will also furnish a speaker to address the Student Chapter of ACS at Purdue University on April 14, 1959. James Mollison presented this report in the absence of Myron Clark.

In the absence of the chairman, Harris O. Ware, Chas. E. Eberly introduced the guest speaker, Brage Golding, of the Lilly Varnish Co. of Indianapolis. Dr. Golding discussed "Functional Coatings" and spoke in detail on classes of coatings with comments on their functions and properties. He also spoke on the primary film forming compounds and on water-soluble, water-dispersible and surface sealing compounds.

March Meeting

Thirty-four members and guests attended the March 17, 1959 meeting at which a panel discussion presented the program, "Facts for the Paper Industry." The panel discussion moderated by W. B. Lincoln, Jr. of Inland Container Corp. included H. O. Ware, Beveridge Paper Co., Keith Cutting of Crown-Zellerbach, and Jack McLaughlin of the Indiana Paper Co.

Mr. Lincoln spoke on the importance of paper in our daily lives and gave examples of its importance throughout the world.

Mr. Ware outlined the utility of market research in the paper industry and spoke on the following items necessary for study when considering a good competitive risk:

1. A product equal or superior to any on the market.
2. An existing market or one that can be created.
3. Raw material sources.
4. A process and a plant.
5. A potential competitive position insured by a suitable manufacturing cost.
6. Patent protection is desirable and often necessary.
7. Competent personnel for the entire enterprise.
8. Continued research and development to maintain the competitive position obtained.
9. A good and understanding management.

Keith Cutting of Crown-Zellerbach spoke on his firm's new plant at St. Francisville, La. which will produce double coated book paper using a new combined roll and knife coating processing machine.

Jack McLaughlin of the Indiana Paper Co. outlined the importance of the paper merchant and his functions as follows:

1. Stocking many grades in quantity.
2. Fabrication.
3. Quick Delivery.
4. Trouble-shooting.
5. Consultant work.
6. Financial Assistance.
7. Information on new items.

This excellent presentation on "Facts for the Paper Industry" was very enthusiastically received. Mr. Ware announced that the meeting on April 21, 1959 would be held in Greencastle, Ind. and would include a tour of the IBM plant there.

JOHN S. SULLIVAN, *Secretary*

Chicago

The most recent meeting of the Chicago Section of TAPPI was held on March 3rd at our usual place of meeting, the Chicago Bar Association facilities, 29 South LaSalle Street, Chicago.

The subject presented that evening was titled "Applications of Scotchgard to Paper and Paperboard, Its Functional Uses and Possible Markets." The speaker was J. M. Thompson, product manager, Industrial Sales Chemical Division, Minnesota Mining & Manufacturing Co.

M. H. Meyer, M. W. Snover, J. M. Thompson, and G. V. Alderson

Inasmuch as it is one of the newer materials possessing some unusual properties, considerable interest was shown by those in attendance. Some of the remarkable features which this material imparts to paperboard and paper surfaces is greater scuff resistance as well as greater resistance to penetration of water and oil. Mr. Thompson's talk covered about forty minutes which was followed by a 30-min. question and answer session.

CARL M. HELM

Empire State (Central District)

The Central District of the Empire State Section of TAPPI held its monthly meeting at the University Club 431 E. Fayette St., Syracuse, N. Y. on March 6, 1959. Sixty-two people sat down to dinner. We had as our speaker O. C. Holland of the Interchemical Corp. of New York. Mr. Holland spoke about the "Magic of Color." His address was both entertaining and informative. After the address we had our usual question and answer period.

MARIE M. MARTIN, *Secretary*

New England (Eastern District)

The fourth dinner meeting of the Eastern District of the New England Section of TAPPI was held on March 9 at Armand's Beacon Terrace in Framingham, Mass. In spite of very poor driving conditions, 106 members attended, enjoyed an excellent meal and heard Austin E. Davis, director of laboratories at Nashua Corp., deliver a stimulating talk on Discrete Particle or Particulate Coating Technology as a lesson in Creative Thinking.

Dave Lovering, program chairman, Arthur D. Little Co., Inc.; John W. Wendell, Jr., vice-chairman Tileston & Hollingsworth Co.; Roger Wiewel, chairman, Weyerhreuser Timber Co.; John Lewis, vice-chairman, New England Section, Lowell Technological Institute; James W. Field, National TAPPI; and Albert C. Lamoureux, secretary, Dennison Mfg. Co.

Chairman Roger Wiewel announced that plans for a joint meeting with the New England Section at Chatham Bars Inn, Chatham, Mass. on June 5 and 6 were shaping up and promised an outstanding weekend. He paid tribute to Charles Horch, retiring chairman, for laying the ground work for such an event and for his leadership in the past and most successful year for the Eastern District.

The chairman then introduced officers at the head table, notably John Wendell, vice-chairman; Thomas Allan in charge of this meeting; John Lewis of Lowell Technology Institute; Thomas Sargent of the Executive Committee and Albert Lamoureux, the secretary. He also introduced J. J. Minelli of Scranton, Pa. as having come the farthest, F. F. Newkirk as active in committee work, and asked Jim Field of the National TAPPI Headquarters to stand.

Dave Lovering, chairman of the Program Committee then introduced the speaker—Austin E. Davis who spoke as follows.

Initially, I had assumed that the subject to be covered would be that of discrete particle coatings in general. However, the announcement indicated that I should cover the narrow area of gummed flat papers. Incidentally, I have had numerous comments about this announced subject and the predominate question raised was this. "How would I dare go into Dennison's backyard and divulge information on Nashua's development of gummed flat paper?"

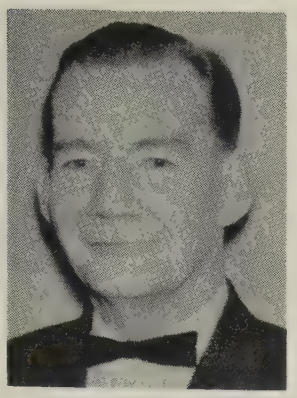
In the first place, I think Dennison is fairly well acquainted with what we have done.

In the second place—I'm not going to say anything about what we are now doing or are going to do in the future any,

In the third place—the Dennison people are nice friendld competitors whom we like to surprise on occasion.

Actually, I am not going to confine my discussion to gummed flats alone—neither am I going to discuss anything of a highly technical nature—rather I would like to say a few words about the successful Nashua story of functional papers through discrete particle or particulate coating technology. Though this will not conform to the announced subject matter—except in part—I hope you will bear with me for I feel that there definitely is a message here that could well be fruitful if applied to your particular areas of interest. This will allow me to cover the ground broadly and not be too specific in any area—this partially answers the question referred to earlier about being in Dennison's backyard.

A man by the name of Lloyd Perry, chief chemist at Nashua for many years and a man that many of you were acquainted with, started this trend at Nashua in the middle 1930's. His starting problem was the development of a paper which would indicate temperature of clothes presses in tailor and cleaning houses. As you can see, this has nothing to do with gummed paper or any other product now sold by Nashua in its line of discrete particle coated papers. It is, however, the item that started Nashua along this road and I consider it a fairly good illustration of what can be accomplished by creative thinking.



A. E. Davis, Nashua Corp.

What was Perry's thinking?—I certainly cannot say but somehow he evolved the idea that pigments did not need to be inorganic materials and that organic materials could be so finely divided as to yield a high degree of opacity and result in a meltable coating satisfactory for his purpose in the development of a temperature indicating paper. Like many a technological success, the result was a business and economic failure for the volume of such paper that could possibly be used throughout the country was found to be insignificant.

Somewhat later, Perry conceived the idea that solid organic chemicals when melted with resinous materials would yield tacky adhesive films. Further experimentation revealed that many such combinations had a tendency to supercool and remain adhesive for long periods of time. It was readily apparent that many compositions after treating and subsequently cooling to room temperature could be applied by pressure alone and were, in effect, pressure sensitive adhesives after being activated. This technique allowed the use of plasticizers in any proportion desired without danger of blocking at ordinary temperatures—and resulted in adhesive temperature requirements considerably lower than those achieved by other compositional techniques. The development of this idea was not easy and though the first practical product was obtained as early as 1944, commercialization did not actually begin until 1947.

Though this development was aimed at tapes, the first application appeared in the labeling field and Nashua's development of this type paper coincided with a high speed labeling machine development by the Lakso Enginering Co. of Fitchburg, Mass. who had undertaken this project for N. J. Machine Co. Many machines now in use with labeling speeds well over 300 per min.—five or more times the speed of normal glue labelers in the mid-forties. Naturally, this created a flurry of excitement and crash machine programs by other manufacturers of glue labeling equipment with the result that speeds on such machines were more than doubled and what looked like a bonanza for Nashua in heat seal label papers at that time has leveled off to a moderately good business due to the economics of initial capital investment plus higher cost of labels. Other label areas, however, have taken up the slack and because of the wide latitude in formulation available through the particulate solid plasticizer technique we have been able to hold a dominating position in these other fields. The patent granted covering this area is considered or was considered at the time of issuance one of the broadest and most fundamental patents published for over 25 years. To our competition, it has, to say the least, been very confusing.

Before getting into the gummed paper area, I would like to say a little about another type of discrete particle which is represented by Nashua's cardiograph paper. We had a desire here to develop a very white opaque coating which would melt and become transparent under a heated stylus. We realized that it would be difficult to obtain these characteristics by techniques employed in the temperature indicating paper development so we were obliged to expand our thinking beyond pigmentation. Again, we went to a fundamental truth that whiteness is the result of perfect reflection of light and attempted to obtain a physical structure using a normally transparent body to obtain the desired results. Considerable thought was given to this problem with the evolution of a very thin film of ethyl cellulose in cellular form on paper which could and is produced continuously and without critical control. In effect, air is our discrete particle, and because of the difference in refractive index between air and the film former and because of the light scattering effect obtained through cell structure, we were able to produce a coating of extreme opacity and whiteness in the weight desired and having rapid response to heat. Again, by such physical structure and the process employed, we have a wide variety of materials from which to choose and can obtain a wide variety of properties as desired.

There is considerable history involved in the manufacture of flat gummed paper, whether it be as labels or ordinary gummed tapes. The attempts have been of international scope though most of the development has been undertaken in the United States. It was natural that for many years such techniques as pigmentation, plasticization, and trick additives were followed. Along with this type of approach came the mechanical or processing development and until late years many experimental hours have been consumed in attempting to process in such a way as to given freedom from normal curling characteristics through widely varying conditions of temperature and humidity. We expect that such activity will continue.

The most important and effective of such methods is the use of "breakers" wherein the adhesive coated sheet is passed over a series of bars set at various angles causing the adhesive layer to be broken into small sections. Theoretically, each small section thus produced reacts independently from all other sections to changes in atmospheric conditions thus lessening the tendency of the sheet to curl. In actual practice, this technique is only partially effective since that portion of the adhesive layer in contact with the paper surface is reinforced by paper fibers and is particularly resistant to rupture. Thus, though the surface of the adhesive layer is broken, the underlying fiber reinforced layer reacts to changes in mositure with sufficient force to induce curl. This processing also weakens the sheet and roughens the printing surface.

Over the years much has been done to modify the physical character of the coating to give easier wetting tapes as well as to improve curl. During my stay at Nashua, we have investigated dusted surfaces, blistered glues, foamed glues, barrier coats, cellular structures, etc. Humphner of Mid States carried on considerable work in the glue dusting technique Stillwell, at Dennison, experimented with rubbery or plastic layers between glue and paper to dissipate strains. Wagner, in Germany, experimented with continuous glue film over lacquer coated paper. In fact, there are reams of prior art attempts and most are partially successful.

The product of Nashua development through the past several years is a truly noncurling gummed paper. That is, it is noncurling if the base sheet is noncurling. Our adhesive coating does not disturb the sheet supplied with regards to physical stress nor does it in any way impair its strength or printing qualities. The adhesive film consists of finely divided adhesive particles in a matrix of water sensitive resinous binder.

We are concerned with many factors in the consideration of both the discrete particle ingredients and the film forming material. The discrete particle adhesive material may be obtained from any of the common water soluble adhesive

materials known in the industry. New polymeric materials may add functional adhesive properties in the future. However, they must be processed in some manner so that in the film they will exist as particles fine enough to be easily brought to adhesiveness when moistened.

More critical are the properties required of the binder since it is the only continuous phase material in the coating and thus, not only must it serve to adhere the particles together and to the paper, it must not practically interfere with adhesive development nor must it set up strains or interfere with the normal expansion and contraction tendencies of the base paper.

The foregoing is an incomplete and quick review of some of the more successful adaptations of particulate coating techniques employed by Nashua's development staff. There have been many more that have been laboratory but not commercial successes. Others are being and can be developed. Outside our own laboratory, consider the NCR Development—do they not use the discrete particle technique?

I feel sure that there are other forms of matter that can be put to wide usefulness. Many fundamental phenomena can be adapted so that in combination with physical and chemical properties of materials a broad base for new developments and new products will become apparent to those that become aware of the potentialities.

Why not combine technology with imagination and ingenuity to create the new?

Mr. Lovering thanked the speaker and assured him that his inspiring message with its broad base in fundamental concepts could find application in any laboratory. He was glad to note another example on the need for patience, where research does not pay off in the same year. He then asked if anyone had questions for Mr. Davis.

In answer to a question as to whether the production of Davac gummed papers required base papers with "negative" curl before gumming, Mr. Davis said that paper underwent no change in this process. The sheet after gumming is as flat as before; however, if you gum a regular or cast coated sheet with curl tendencies before gumming, curl will also be found after gumming.

He was also asked if they had to gum one particular side of the sheet, felt or wire. Mr. Davis replied that on easy sheets, such as English finish stocks, either side was satisfactory.

Asked if such a discontinuous film gave as good adhesive performance as the conventional "guaranteed flat" type of gumming, the speaker answered in the affirmative.

Someone asked how these small particles were obtained. Mr. Davis pointed out that dextrin could be purchased of such a fineness that 98% passed through a 325 mesh screen.

Several questions were aked relative to the use of such a system for applying asphalt to paper for waterproofing. Mr. Davis pointed out that the coating would be free from curl as long as the particles were discontinuous in a suitable binder but that if you destroy the discrete particle system, as by heating to fuse the particles together, then you lose the advantages of such a system. He agreed that asphalt applied by the technique in question should penetrate less and that it might be possible to reduce the amount of coating necessary for lamination or waterproofing. Other types of coating might benefit from the system described tonight but the absence of curl would be obtained in many cases at higher cost than by such conventional coatings as are regularly bound with casein or with such relatively low cost binders.

Replying to questions on printability, Mr. Davis pointed out that these discrete particle coatings, deposited from organic solvents, are porous and, like porous surfaces, can be printed by any of the conventional types of printing. It makes little difference whether the particles are dextrin, glue or titanium dioxide.

The question of depositing such discrete particle coatings from water was said to be quite complex and not a good subject for discussion at this time. One such question about depositing heat seal coatings from water mix was classified as not impossible but required delicate selection of materials and proportions for balance. In the case of water activatable gummings, you might consider some water but not with glue.

Mr. Lovering pointed out that these principles touched in so many areas that this discussion could continue all night but suggested closing the meeting after asking for comments on the talks presented at these meetings and inviting suggestions for future subjects of equally interesting nature. Mr. Davis was given warm applause.

A. C. Lamoureux, *Secretary*

Pacific

The Pacific Section TAPPI held its third meeting of the year at Aberdeen, Wash., Jan. 20, 1959. The technical meeting was held in the Lodge Room of the Aberdeen Elks Club where papers on technical control methods were presented. Curt Walseth, of Weyerhaeuser Timber Co., Cosmopolis, was the moderator for the program which began promptly at 2:00 p.m. P. M. Toppari, Rayonier, Inc., Hoquiam, ably handled the arrangements for the meeting.

C. S. Walseth, Weyerhaeuser Timber Co.

The following papers were presented.

1. "The Waring Blendor as a Laboratory Beater" by B. J. Jacoby, Crown Zellerbach, Camas.
2. "The Performance of an Automatic Titrator as an aid in Routine Pulp Testing" by A. J. Beauchamp, Crown Zellerbach, Camas.
3. "Weighing Chips by Scow Displacement" by Vance Reynolds, Puget Sound Pulp and Timber Co., Bellingham.
4. "Application of Wet Ashing to the Analysis of Pulp Mill Samples" by Luella Johnson, Puget Sound Pulp and Timber, Bellingham.
5. "Control Sampling of Pulp Mill Effluent" by Fred A. Westfall, Scott Paper Co., Everett.
6. "Quick Brightness Test on Slush Stock" by John M. Elder, Weyerhaeuser Kraft Mill, Everett.
7. "Improved Procedure for Estimation of Certain Sulphur Compounds in Kraft Pulp Mill Effluent Streams" by J. L.

Fred A. Westfall, Scott Paper Co.; John M. Elder, Weyerhaeuser Timber Co.; Vincent F. Fellicetta, University of Washington; and J. H. Baxter, Crown Zellerbach Corp.

B. J. Jacoby and A. J. Beauchamp, Crown Zellerbach Corp.; Vance Reynolds and Mrs. Luella Johnson, Puget Sound Pulp & Timber Co.

McCarthy and V. F. Fellicetta, Chemical Engineering Department, University of Washington.

8. "Testing the Printability of Pulps" by J. H. Baxter, Crown Zellerbach, West Linn, Ore.

The technical meeting was very well attended and the papers presented elicited many questions from the audience. A social hour at 5:30 in the Antler Room of the Elks Club preceded the dinner served at the Morck Hotel. Charles E. Young, economist, Weyerhaeuser Timber Co., Tacoma, Wash., was our after dinner speaker, and the subject of his presentation was the "Economic Outlook for Pulp and Paper." A near record attendance at a meeting of this type testified to the interest in the Pacific Section programs and the growth of the Grays Harbor area pulp and paper industry.

ROBERT SMYTHE, *Secretary-Treasurer*

The Waring Blendor as a Laboratory Beater

B. J. Jacoby

DURING the past several years, our pulp production at Camas has been expanded both at to tonnage and grades produced. These included the expansion and modernization of our kraft pulping facilities including the installation of a Pandia continuous digester and the installation of a new 300-ton kraft bleach plant. The expanded pulping facilities also made possible an increase in number of grades of pulp that could be produced at one time.

B. J. JACOBY, Pulp Quality Chemist, Crown Zellerbach Corp., Camas, Wash.

Part of the audience at the Pacific Section meeting

Table I. Reproducibility of Blendor Test
(All tests on identical sample)

Date tested	*% Burst*	*Canadian Std. freeness, ml.*
8/26/58	59	545
8/27/58	56	530
8/27/58	59	530
8/30/58	57	520
9/2/58	58	540
9/3/58	58	530
9/4/58	60	520
9/5/58	56	535
10/15/58	58	550
Maximum	60	550
Minimum	56	520
Average	58	533

Because of these improvements, we have had increasing demands for more pulp control tests. In order to meet these demands without increasing our work force we have been forced to examine our pulp testing methods to determine where it is possible to save time and still maintain our usual standards of accuracy and reliability.

One test that has helped us considerably in this respect is the Waring Blendor test. We have been using the Blendor as a laboratory pulp refiner, in order to make strength tests on the soft pulps manufactured at Camas. These include soft unbleached sulphite, caustic treated soft bleached sulphite, and bleached cottonwood kraft. Our investigations also indicate that this instrument can be used for testing all grades of unbleached and bleached sulfite pulps. The Blendor, however, does not appear to be satisfactory for testing softwood kraft pulps.

The Blendor that we use is the regular two-speed quart-sized Waring Blendor with stainless steel cup.

The advantages of this device which make it very desirable as a pulp strength test are as follows.

1. It is dependable: (a) good reproducibility and (b) simplicity of operation reduces human error.
2. It is economical: (a) saves at least 50% of testing time over our former method, (b) low initial cost—approximately $40, and (c) low maintenance costs.
3. It is fast: (a) Rapidity of testing makes good control test.

The only disadvantages that we have experienced so far are:

1. The Blendor does not work well on strong softwood kraft pulps. Tests both at Camas and St. Helens Division of Crown Zellerbach have indicated that this test is not satisfactory for these pulps.
2. Small capacity—the quart-sized Blendor holds only enough for a freeness test and two or three handsheets; therefore, if it is desired to make incremental tests similar to the standard beater test, it is necessary to weigh out several samples and make individual tests on each. This, however, is still approximately one half as time consuming as running a standard beater test.

In evaluating the Blendor, we originally made our comparisons with the Morden testing machine—this is a jordan-type instrument that we have been using for several years as a laboratory refiner at Camas. We found that the Waring Blendor could give us the same information as the Morden regarding the strength of our soft pulps, and that it appeared

Table II. Sensitivity of Blendor Test

Sample no.	*Grade*	*Morden —test at 2 min.— % Burst*	*Morden —test at 2 min.— Freeness*	*Blendor —test at 2 min.— % Burst*	*Blendor —test at 2 min.— Freeness*
1.	Strong bl. sulphite	88	480	91	540
2.	Caustic treated soft bleached sulphite	57	440	60	525

Table III. Blendor Tests versus Beater Tests on Unbleached Sulphite Pulps

	Sample no. 1	*Sample no. 2*	*Sample no. 3*	*Sample no. 4*
Wiles no.	3.5	4.8	9.1	10.2
TAPPI $KMnO_4$ no.	7.6	10.0	17.7	19.4
% Burst at 600 ml. freeness				
Beater test	100	89	106	105
Blendor test	86	95	103	102
% Burst at 400 ml. freeness				
Beater test	109	106	124	120
Blendor test	100	112	120	117
Grams tear at 600 ml. freeness				
Beater test	1.07	1.12	1.26	1.06
Blendor test	1.01	1.20	1.20	1.20
Grams tear at 400 ml. freeness				
Beater test	0.93	1.00	1.04	0.98
Blendor test	0.92	1.10	1.11	1.04

to be at least as reproducible if not more reproducible than the Morden test (Table I). It also gives us comparable information to the Morden test as to the bursting strength of the pulp (Table II).

Comparisons have also been made between the Blendor and the laboratory beater. These tests were made by beating separate samples for 1, 2, 3, and 4-min. in the Blendor, running freeness, and making handsheets from each sample. Curves were then prepared in the usual manner so that direct comparisons could be made between the Blendor and beater test curves. Results of these comparisons are shown in Table III. They indicate that the Blendor test gives similar information regarding bursting strength and tear properties of unbleached sulphite pulp as does the beater test.

Testing conditions used at Camas are as follows.

1. Five and a half grams of moisture-free pulp are made up to 350 ml. to make a consistency of 1.57%.
2. Beating time—2 min. at high speed.
3. Beating temperature—68°F.
4. Entire sample used for freeness and two handsheets.

This procedure was modified for testing regular unbleached sulphite to compare with beater tests as follows:

1. Three and six tenths grams of moisture-free pulp were made up to 350 ml. to make a consistency of 1.03%.
2. Beating time—0, 1, 2, 3, 4 min.
3. Freeness and strength sheets were run on the same sample.

This modification resulted in more rapid freeness drop, but very little effect on burst or tear. The purpose was to reduce hanging up of pulp in top of cup, which affected reproducibility of the test.

In conclusion, the successful use of the Waring Blendor as a laboratory refiner has saved us considerable time in our strength testing program. This, along with other time saving improvements has enabled us to give the operating departments the required extra pulp testing service made necessary by recent expansions, without increasing our work force.

Presented at the meeting of the Pacific Section of TAPPI held in Aberdeen, Wash., Jan. 20, 1959.

The Performance of an Automatic Titrator as an Aid in Routine Pulp Testing

A. J. Beauchamp

As mentioned by Mr. Jacoby in his presentation, modified methods and new testing equipment to justify the means for labor savings are of extreme importance. With the increases in pulp production, the additions of a Pandia digester, and a new plant for bleaching kraft, work loads in our pulp testing program became quite top-heavy. Some improvement was made by the redistribution of some of the duties, but this was not enough. The development of an automatic device to perform pulp titrations, which is one of our most frequent tests, came about as a direct result of this. In April of 1957, a paper was given at the annual Shibley Award meeting, on this subject. For those of you here today, who were present at that meeting, I would like to refresh your memory of the functions of the device, and for those who were not, I would like to briefly acquaint you with the automatic process as applied to the modified method of a pulp titration.

The normal amounts of pulp, water and acid are added to the beaker. A pipet of potassium permanganate is held ready, an upon depression of the starting switch, which actuates the motor stirrer and program timer, the permanganate is then released. From this point on, the rest of the titration is completely automatic. The slurry is agitated for exactly 5 min., which is the constant reaction time for the oxidation process, then valve 1 delivers the prescribed volume of potassium iodide and stops the reaction. Immediately after valve 1 completes its flow, valve 3 delivers what we term as the initial flow of sodium thiosulphate. Just how much of this solution is delivered depends on the extent of the cook, which we determine from the report sheet issued with each individual cook. Valve 3 is controlled by a separate adjustable timer by which we may select a flow that is somewhat short of the actual end point. During this flow, the light source and the photoelectric relay are activated. They are placed adjacent to both sides of the beaker, so that efficient light transmission to the photocell may be accomplished. Since the slurry at this time is fairly light in color, the relay is not actuated by light cut-off until valve 2, now activated by the program timer, delivers the starch indicator solution, and turns the slurry a deep blue color. The relay then takes over the job of delivering the titrant through valve 4. This valve has been adjusted for a drop by drop flow, and when the near end point is sensed by the photocell, this flow is stopped by deactivation of the relay at exactly the end point. All that remains to be done is to take a buret reading of the titrant and determine the permanganate number.

The savings in time and labor derived from the use of this apparatus as a routine testing device can be appraised in this manner. Since the installation of this model which was invented and constructed at the Camas mill for use on sulphite pulps, early in April of 1957, some 15,000 tests have been run on it. First and most important point, of course, is its accuracy. By setting up a program of routine back titration, we have found that the average for the greater bulk of these tests comes to exactly the end point. The relatively few tests that have gone a few drops beyond the end point are the result of two correctionable factors. One is due to the decrease in light intensity as a result of fatigue after about 400 hr. of operation, and the other is due to low photocell output after about 600 hr. of operation. We have even been able to extend the life of these somewhat, by adjusting the resistance in the relay circuitry to compensate for the ambient light characteristics.

The savings in time, by the ability of the titrator to function faster than the human element normally would dare to, in a test of this nature, amount to about $1^1/_2$ min. per test. This does not seem like a great deal of time, but keep in mind that after initiation of the starting switch, the testing personnel is freed from the rest of the entire test. This is a most important point, because with the help of this apparatus, along with improvements such as the one Mr. Jacoby described, we at Camas, have been able to increase our testing capacity, keep abreast of increased production, and still give as good, if not better, service to our line operations.

No doubt, the question will be raised—just how much does

A. J. Beauchamp, Pulp Technician, Crown Zellerbach Corp., Camas, Wash.

one of these devices cost, and does its cost justify its installation and use? For the first part, we do not exactly know, since the device is not yet on the market. We do know that the components run in the neighborhood of $350.00. Fabrication of parts in development of this sort is very time consuming, and certainly not without its failures, and for this reason, labor costs are quite hazy. As for the second part of the question, as to its justification, I am qualified to say that we feel the original model has long since been paid for, with enough left over to construct several titrators.

An improved model was constructed, and has been in practical use for 6 months in the new kraft bleach plant at Camas. It was designed to operate in the permanganate consumption levels that they require. It has proved an invaluable aid to the operators, as it allows them to spend more of their time for closer control.

Maintenance on these models has not posed any problem. Nothing has had to be done, with the exception of periodic changes of lamps, photocells and stirrer motor brushes.

A new model is going to be built in the very near future. By modifying it somewhat, we will be able to make it flexible enough to handle all types of pulp. All of our pulp titrations then, will be run on automatic equipment. We expect, by this, to increase our capacity for even more pulp titrations, have more consistent control, eliminate the human error in this phase of testing, and to round out an even more efficient testing program.

Presented at the meeting of the Pacific Section of TAPPI held in Aberdeen, Wash., on Jan. 20, 1959.

Weighing Chips by Scow Displacement

Vance Reynolds

Many pulp mills in the Pacific Northwest are augmenting normal wood supplies by purchasing saw mill waste in the form of precut chips. These chips are an important source of pulp wood and their use is a profitable means of waste disposal for the sawmill and an excellent conservation measure. Chips are transported to the pulp mills by truck, rail and over water by scow. When location of the selling and receiving mills makes it possible, shipment of the chips by scow has proved to be an inexpensive transportation means.

Some mills purchase chips on a volume basis; determined by scaling the scow load. The volume system however must be converted to a weight basis to be employed in customary accounting methods and mill yield calculation. Chip volume varies with wood density, chip size and shape, scow loading method, and with weather conditions during transit. Thus the use of a factor to convert volume measurements to weight will give only rough estimates of true chip weight.

Some mills weigh scow chips by unloading into trucks which are then weighed on scales. This system gives accurate weight measurement but requires trucks, drivers, and considerable time to unload a scow. The Puget Sound Pulp & Timber Co. unloads their chip scows, with a crane, directly onto a belt conveyor equipped with an integrating weightometer. The scow load weight is then determined by applying a predetermined weightometer calibration factor to the integrator count. Experience with this weightometer has revealed several factors which affect precision, the most serious of which is variation in belt load.

An accurate and easily executed auxiliary method of measuring weight was desired so that weightometer variation could be determined, studied, and, if necessary, corrected.

DESCRIPTION OF METHOD

A relatively simple means of determining weight is the measurement of the volume of water displaced by a floating object. In the case of scow delivered chips, the change in water displacement of the scow during unloading is a measure of the weight of chips removed.

Vance Reynolds, Chemical Engineer, Puget Sound Pulp & Timber Co., Bellingham, Wash.

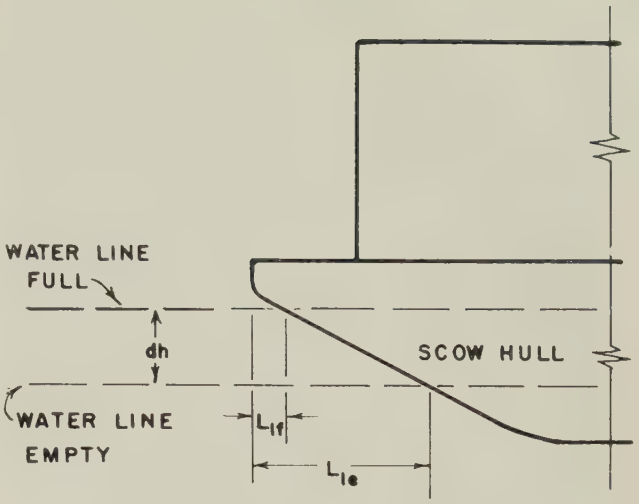


Fig. 1. Scow dimension designations

The data required to make displacement change calculations includes the length and width of the scow hull, the vertical change in the water line, and the density of the water. Width is constant, for the scows are straight sided. The change in draft due to unloading is also approximately constant although it may vary slightly from bow to stern and from port to starboard when the scow is unevenly loaded. The length of these scows is not constant with draft for both bow and stern slope inward as shown on Fig. 1.

The geometric volume representing the displacement change due to unloading is essentially a doubly truncated rectangular prism with volume

$$V = dh\ (W)\ (L_f + L_e)/2$$

where

dh = average change in draft.
W = width of the hull.
L_f = length of hull at the waterline when full.
L_e = length of hull at the waterline when empty.

The change in draft dh may be determined from the scow deck by measuring the distance from the deck to the waterline (freeboard) with the scow full and again empty. These measurements are taken at each corner of the scow to the nearest 0.1 in., and are averaged for a full and empty scow.

Hull width W is measured on the deck to the nearest inch. Care must be taken with this measurement that bumpers are not included.

The lengths of the hull at the waterline when full (L_f) and empty (L_e) are also determined from the deck. First the length of the deck L is measured to the nearest inch. Then with the scow full, the horizontal distances L_{1f} and L_{2f} (Figure 1) from the ends of the deck back to the transverse waterlines at the bow and stern are measured to the nearest inch. A plumb line will assist in determining the points on deck directly above these transverse waterlines. Similar measurements are made with the scow empty to determine L_{1e} and L_{2e}. The lengths of the hull at the waterline when full and empty are then:

$$L_f = L - L_{1f} - L_{2f}$$

and

$$L_e = L - L_{1e} - L_{2e}$$

The weight of chips unloaded may be calculated from the change in displacement, incorporating appropriate conversion factors and the density of the water in which the scow floats:

Tons of chips = (cubic inch displacement) (water density)/(1728) (2000)

Water density will vary with location, and with temperature. The temperature variation amounts to only 0.01% per degree Fahrenheit in the range of 32 to 60°F. so it may be neglected for practical purposes. However, density may vary appreciably when the mill site is adjacent to fresh water streams, or subjected to large quantities of wastes. The water at the measuring site should be checked carefully, therefore, to determine if the density variations are significant or whether a constant density may be employed.

The length and width of the deck are constants for each scow. The length of the hull at the waterline when empty and the slope of the bow and stern are constant, for all practical purposes. Therefore, these measurements need be made only once on each scow. The length of the hull at the waterline when full is directly proportional to the scow load and hence to the change in draft due to unloading. Thus after a scow is once measured the combined slope of bow and stern may be calculated.

$$\text{Slope} = (S) = (L_f - L_e)/dh$$

The equation for chip weight may then be expressed.

$$\text{Tons} = (dh)\,(W)\left[(L_e) + \frac{(S)\,(dh)}{2}\right]\frac{\text{density}}{1728\,(2000)}$$

where all measurements except dh are constants for a particular scow. Once these constants are determined the equation reduces to

$$\text{Tons} = F_1(dh) + F_2\,(dh)^2$$

where F_1 and F_2 for each scow are equal to

$$F_1 = (L_e)\,(W)\,(\text{density})/(1728)\,(2000)$$
$$F_2 = (S)\,(W)\,(\text{density})/(2)\,(1728)\,(2000)$$

Thus, it is only necessary to measure the change in draft dh to calculate the weight of subsequent loads.

SPECIAL EQUIPMENT

Freeboard measurements to within 1 in. are difficult unless the water is calm and accuracies of 0.1 in. are nearly impossible with an ordinary tape or plumb line. It was therefore necessary to design a device to measure average waterline distance to 0.1 in. even under extreme weather conditions.

The device (Fig. 2) consists of an air filled diaphragm box, connected to a water filled manometer with flexible Saran tubing and supported by a flexible cable. The cable is marked at 1-ft. intervals and is fastened by an adjustable clamp to the manometer mounting board.

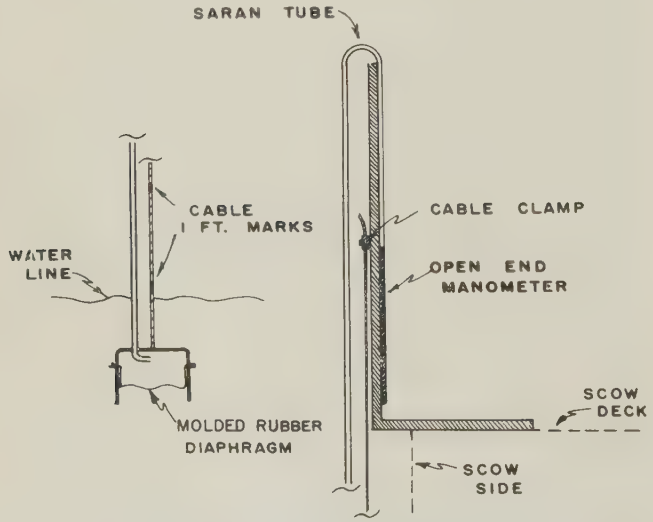


Fig. 2. Freeboard manometer

Table I

Measurement	*Estimated maximum error*	*Maximum error, % of chip weight*
Scow length	±2 in.	±0.14
Scow width	±1 in.	±0.19
Change in length	±6 in.	±0.21
Change in draft	±0.2 in.	±0.31
Water density	±0.003 sp. gr.	±0.30

To measure waterline distance, the diaphragm box is suspended just below the water surface and the cable is clamped at the foot mark nearest to and above the actual distance to the waterline. The manometer base must be placed flat on the scow deck. The submerged distance from deck to waterline will then be the number of feet indicated where the cable is clamped to the manometer, less the manometer reading in inches of water. For actual calibration the device was equipped with an inverse manometer scale and appropriate adjustment of the cable foot marks so that manometer readings are added rather than subtracted.

The differences in full and empty freeboard is taken as the change in draft. Therefore it is essential that measurements after unloading be made from the same point on the deck as those made on the full scow. To insure that this is done an outline of the manometer base has been painted on each corner of all scows regularly used to deliver chips.

Waves will cause a fluctuating manometer reading as the water level directly above the diaphragm box varies. Also, waves, wind, and tides often cause the scow to pitch and roll a measurable amount, to cause additional fluctuation of the manometer. A simple damping device was constructed of a 1 in. piece of 1/2 in. copper tubing packed with glass wool. With this damper attached to the open end of the manometer, average diaphragm submersion is easily read.

ACCURACY OF THE METHOD

There are several possible errors associated with the displacement method, the magnitudes of which are dependent on the care exercised in measurement. Table I shows these possible errors, an estimate of their magnitude, and the effect of each on the calculated chip weight. Possible errors were estimated after weighing over 200 scow loads of chips by the method. The maximum errors expressed as per cent of chip weight in Table I are based on an average scow 125 ft. long 44 ft. wide, with a change in draft of 65 in. This represents approximately 900 tons of wet chips.

The sum of the errors in Table I is ±1.15% which represents the error in chip weight which would be made if all the maximum measurement errors were made in the same direction.

The actual magnitude of variation associated with the method has been estimated by taking replicate measurements on the same load. For the purpose of this comparison, a scow difficult to measure was used and measurements were made under adverse weather conditions. Four operators, all unskilled laborers, and two supervisors, familiar with the procedure, made independent measurements with results as tabulated in Table II.

The standard deviation of the individual chip weight values in Table II from the average value is 2.55 tons or 0.25% of the

Table II

Operator	*Deck length, in.*	*Deck width, in.*	*Length change, in.*	*Draft change, in.*	*Chip wt., tons*
1	1560	516	129	71.5	1007.3
2	1558	514	124	71.5	1003.8
3	1560	515	137	71.3	1002.7
4	1560	515	136	71.3	1000.5
5	1558	514	133	71.5	1000.4
6	1560	516	137	71.4	1003.4
Average	1559	515	133	71.45	1003.1

Table III

Load No.	Chip weight, tons: Scale	Chip weight, tons: Displacement	Deviation, %
1	482.28	484.31	0.42
2	636.50	637.06	0.08

average. A statistical estimate may therefore be made that 50% of the time values would be obtained within $\pm 0.17\%$ (0.6745σ) of the average if an infinite number of tests were run. Similarly, values within $\pm 0.67\%$ (3σ) of the average would be obtained virtually every time.

Additional checks on the accuracy of the methods have been made with the cooperation of the Soundview Division of Scott Paper Co. In this case a skilled engineer made the displacement measurements. Scott utilizes scow delivered chips which are weighed on truck scales. Two scow loads were weighed by the displacement method at Everett and the total chip weight checked on the truck scales. It may be seen from the results in Table III that excellent agreement between the two methods were obtained.

SUMMARY

Scow displacement weighing of chips is a relatively precise method requiring little equipment and manpower. After initial measurements have been made on a scow, subsequent loads can be measured by one man in 15 min. With this weighing method, any desired unloading procedure may be followed without interference by weighing. Data collected during 6 months of use indicate that weighing error is less than $\pm 1.0\%$.

Presented at the meeting of the Pacific Section of TAPPI held in Aberdeen, Wash., on Jan. 20, 1959.

The Application of Wet Ashing to the Analysis of Pulp Mill Samples

Luella Johnson

THE application of wet ashing with perchloric acid to the analysis of pulp mill samples can be very beneficial, and when used with simple precautions the procedure need not be dangerous. The precautions recommended are those suggested by Smith (*1*) and others (*2*). These are the use of nitric acid in conjunction with the percholoric acid and the use of adequate hood facilities.

The purpose of the nitric acid is to destroy the easily oxidizable material, and to effect a slow increase in the concentration and temperature of the perchloric acid as the excess nitric acid is evaporated. This gradual increase in concentration and temperature permits a slow, controlled oxidation of the resistant organic residue.

Adequate hood facilities are needed to keep perchloric fumes away from organic material in the laboratory. An ordinary hood with metal or ceramic covering and adequate ventilation is suitable; if greater care seems necessary, or if a wooden hood is used, special apparatus (*1*) can be employed to carry all the fumes into a caustic trap.

Wet ashing can be used in the preparation of pulp, spent sulphite liquor and miscellaneous mill samples for elemental analysis. It cannot be used when an actual value for ash is required nor is it recommended for large samples high in organic matter. On the other hand, with most types of samples the method offers many advantages. It is rapid, especially with a large number of samples; there is no ignition loss; no necessity of drying liquid samples; and the prodedure invariably furnishes a homogeneous solution. This is important with samples containing metals such as iron becasue the fusion step, usually necessary in the dry ashing method, is eliminated.

LUELLA JOHNSON, Chemist, Puget Sound Pulp & Timber Co., Bellingham, Wash.

A good example of the wet ashing procedure is its application in the determination of total sulphur in spent sulphite liquor (*2*).

To an accurately measured sample containing about 0.3 g. of solids add a few milliliters of water and 10 ml. of 70% nitric acid. After a thorough mixing, add 6 ml. of 70% perchloric acid and heat gently to drive off the nitrogen dioxide fumes. If the solution darkens suddenly at this point, cool, add more nitric acid and heat to perchloric fumes. No such darkening should occur if sufficient nitric acid has been added initially. As a general rule add at least 10 ml. of nitric acid for each gram of organic matter. To remove the last trace of nitric acid, cool the solution, add 3 to 5 ml. of hydrochloric acid and reheat to perchloric acid fumes. Treat the resulting solution in the usual manner for sulphate determination. The precipitate of barium sulphate is very coarse and settles so quickly it can be filtered after a digestion period of 2 hr. or less.

The same general procedure has proved successful in preparing a variety of pulp mill samples for elemental analysis by the common volumetric, colorimetric, gravimetric and flame emission methods. We have used the procedure in the volumetric determination of such metals as calcium and iron; in colorimetric tests employing such reagents as titan yellow, orthophenanthroline, ammonium thiocyanate, diethyldithiocarbamate and periodate for determining magnesium, iron, copper and manganese; and in the gravimetric determination of magnesium, total sulphur and silica. The latter is in a dehydrated state at the conclusion of the wet ashing and is readily filtered off, ignited, and weighed. In flame spectrophotometric analysis, the presence of perchloric acid in the sample has no harmful effect in the determination of sodium, potassium, or calcium.

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Presented at the meeting of the Pacific Section of TAPPI held in Aberdeen, Wash., Jan. 20, 1959.

Control Sampling of Pulp Mill Effluent

Fred A. Westfall

THE general theme of today's program is "Control Methods." I would like to tell you something about our control methods relating to mill effluent and some of the background that prompted the selection of this subject.

We are vitally interested in the contents of our mill effluents, as are all of the mills, from two standpoints, the first being the effect on our efficiency of operation from the loss of useable fiber, and the second being the effect on the waters of Puget Sound in the area adjacent to the mill. Here we could immediately become involved in so many items that time would not permit their coverage, so we will confine ourselves solely to the pulp mill and thence only to the control of total combustible solids.

Returning to the two points of interest previously mentioned, we can go a bit further and say that these total combustible solids could be made up of useable fiber, the loss of which would be hurting our efficiency, and they could further be made up of fines, tailings screen rejects and knotter rejects, which together with the useable fiber could discharge into the waters of Puget Sound and detract from their value for multiple use. We are constantly striving to lower the total combustible solids in our effluents, and their measurement is one of the important functions of the pulp mill technical control department.

FRED A. WESTFALL, Instrument Supervisor, West Coast Div., Scott Paper Co., Everett, Wash.

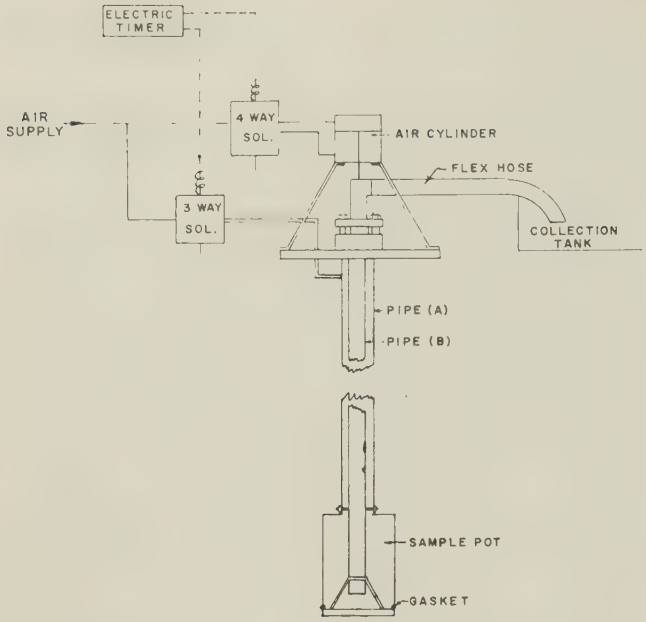


Fig. 1

We have two effluent lines leaving the pulp mill, one from the blow pits and one that covers the balance of the process. The line leaving the blow pits goes into a sump and the effluent is then pumped away to our deep water diffuser line. Here sampling is fairly easy. A timer operating a solenoid valve that in turn supplies air to a small Saunders-type cylinder operated valve opens this valve every 15 min. for 5 sec., letting a sample into a stainless steel collection vessel. Every 8 hr. this composited sample is checked by the technical control department for useable fiber. Should high results be encountered, operating and maintenance personnel are notified, the source of loss located and corrected.

The second and most important effluent line, covering the balance of the mill, has for years presented a real problem in sampling. This line is 6 ft. in diameter; where it leaves the mill the top of the line is 4 ft. below the ground; the discharge is below water level, so that the level in the line is affected by tides; chemicals from the first two stages of bleaching make the effluent corrosive; and particle size varies widely. The normal sources of combustible solids in this line are washer, thickener, and decker effluents. The unusual and controllable sources are from holes in thickener or washer wires; defective deckle straps; flooded washers, thickeners, or deckers; flooded Johnson knotters; and stock spills. The material sometimes lost from the Johnson knotters is in the form of uncooked or burned chips and knots and so of large size.

Several types of samplers were tried in this application and because of the factors involved were not suitable, owing to high maintenance costs and frequency of breakdown. We finally made up a list of the design features desired for the sampler and they were as follows: (1) it should not classify, (2) should always take the same size sample, (3) not involve a pump, (4) have no close tolerances or machine fits, and (5) be entirely constructed of highly corrosion resistant materials. Jack Kramer, assistant instrument supervisor, proposed a pneumatically operated sampler, and as it covered the desired points, we constructed one in our shop and installed it a year ago this month. To date it has been very satisfactory. This sampler is again timer-operated and samples every 15 min. Technical control personnel then take a sample of the composite every 8 hr. and measure the useable fiber and the total combustible solids. On a regular weekly schedule technical control takes samples of effluent at every washer, thickener, and decker in the plant at some 40-odd sampling points. They therefore have normal levels established for each point and should the main effluent line sampler show high loss not caused by a known stock loss, the control personnel check all of their sampling points and the source of loss is easily located.

The sampler (Fig. 1) for this main effluent line consists of a $1^1/_2$ in. by 10 ft. long pipe, with an 8 by 6-in. diam. pot on the bottom end. Inside this pipe is a $^3/_4$-in. pipe with a free floating lid on the bottom and coupled to an air operated cylinder at the top. The outer pipe is welded at the top to a standard blind flange. The inner pipe passes through the flange with a stuffing box and is guided near the lower end so that it slides straight up and down inside of the outer pipe. The sampler is installed through a manhole and extends far enough into the effluent line so that the pot is always covered. Any level over the pot fills only the small concentric area between pipes A and B, which is so small by comparison with the volume of the sample pot as not to affect appreciably the sample size. A timer energizes a four-way solenoid which operates the air cylinder opening the sample pot. The time interval is set sufficient to fill the pot, the solenoid is de-energized and the lid closed. The timer then energizes a three-way solenoid and puts air pressure just under the blind flange in the space between the inner and outer pipes. The air pressure forces the sample up the inner pipe and into a collection vessel. The timer can be set for any frequency desired. Construction of the sampler except for the blind flange is all 316 stainless steel. The gasket at the bottom of the pot is polyethylene covered refrigerator door gasket.

An article by Mr. Kramer describing the sampler is being published in the January 26 issue of *Chemical Engineering*.

Presented at the meeting of the Pacific Section of TAPPI held in Aberdeen Wash., Jan. 20, 1959.

Quick Brightness Test on Slush Stock

John M. Elder

It was felt desirable to use brightness to help control bleaching in the Everett kraft mill. This brightness would be measured on the slush stock at several stages in the bleaching process. For maximum effectiveness, the test for this brightness should be quick and fairly accurate. The TAPPI method, which involves the making of TAPPI sheets and drying them from 2 to 4 hr. at 50% humidity, takes too much time and labor.

As the TAPPI method was not feasible, a substitute method was tried, using a Photovolt reflection meter. The Photovolt reflection meter is a photoelectric measuring instrument which can measure brightness, opacity, gloss, and color. It consists of two parts: (1) the instrument proper which contains the indicating instrument, the power supply, and the controls; and (2) a search unit, which is connected to the instrument by cable and contains the light source, the optical system, and the photocell unit. The search unit registers reflectance in the same wave-band as the G.E. meter, but differs in the angle of reflection. The photovolt reflects at 90°, the G.E. at 45°. This means that surface characteristics have less effect on the photovolt reading than on the G.E. Also, the Photovolt views a larger area than the G.E., which tends to make the photovolt readings more uniform. Of no little importance is the price of a Photovolt. Its cost is about 15% of a G.E. meter.

The first method used was to read Photovolt brightness on centrifuge strips made from the stock to be tested. This method was quick enough, requiring about 5 min. per test, but it gave quite erratic results. The brightness reading varied according to the surface characteristics of the strip and the moisture. This test was so undependable that it was finally dropped.

John M. Elder, Proj. Chemical Engineer, Everett Kraft Mill, Weyerhaeuser Timber Co., Everett, Wash.

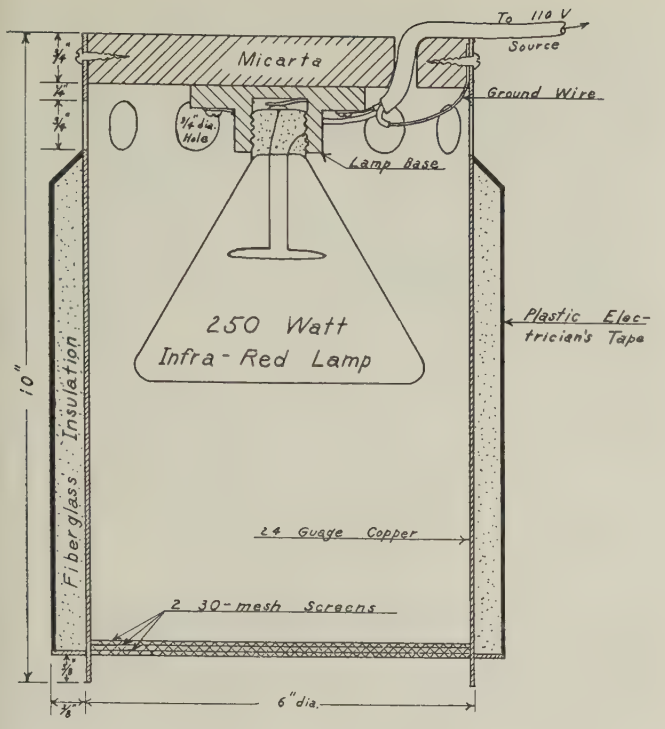


Fig. 1. Photovolt pad drier

Next, the Photovolt method recently developed at Weyerhaeuser's Longview Pulp Division was tried. In this method the pulp sample was slurried with water and formed into a sheet in a Buchner funnel. A vacuum pump was used on the filter flask and the pad was sucked dry for 15 min. This method gave reliable results, but took nearly 20 min. per test, which was too long.

It was decided to try to speed up the Longview method. The 15-min. suction time was the bottleneck as it was necessary to get the pad to a certain dryness before reproducible brightness readings could be obtained. Shortening the suction time gave erratic readings, caused by the larger amount of mositure left in the sample.

PAD DRIER

A drier was built to speed up mositure removal from the sample (see Fig. 1). It consists of an insulated metal cylinder 10 in. high and 6 in. in diameter—slightly less than the Buchner funnel. A 250-watt infrared lamp is mounted in the top of the cylinder and two 20-mesh diffusion screens are mounted near the bottom. Holes are cut in the cylinder near the top to admit air, and the bottom has a flange around the outside to prevent the cylinder from going to the bottom of the Buchner. The flange also makes the joint between the Buchner and the cylinder more nearly airtight so that incoming air will enter the holes at the top and be warmed as it flows around the hot infrared lamp. The pad is dried by the warm air passing through it and by the infrared rays striking the surface. The two screens near the bottom of the cylinder are to diffuse the infrared rays. Without diffusion screens it was found that the center of the pad browned from overheating and read 2 or 3 points low.

The drier cylinder is closed at the top by a 3/4-in. disk of plywood fastened by four screws. A socket base is attached to the under side of the disk and holds the infrared lamp bulb.

BRIGHTNESS TEST USING DRIER (see Fig. 3)

The drier is connected to a timer which also controls the vacuum pump. After the pulp sample is poured into the Buchner funnel the drier is placed on top of the funnel and the timer is started. The timer starts both the pump and the

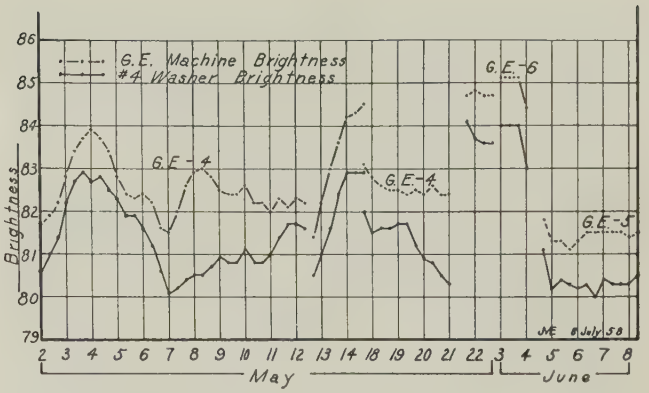


Fig. 2. Relationship between Photovolt on no. 4 washer and G.E. machine brightness

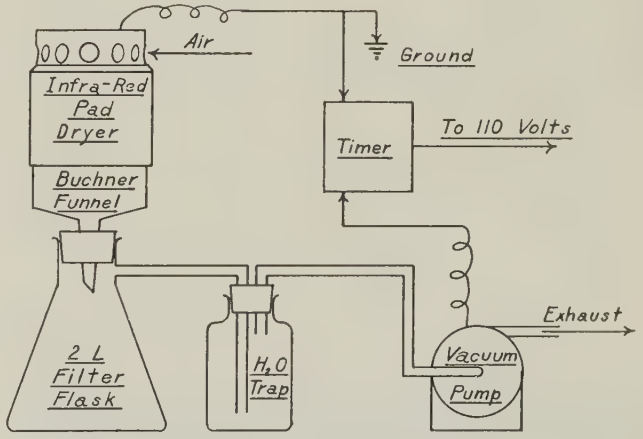
Brightnesses were averaged by shift, then a moving average of 3 plotted.

infrared lamp in the drier. The timer is set for 4 min., after which it turns pump and lamp off. Thus, if the sample pad is not removed immediately after the pump stops, the brightness will not be affected.

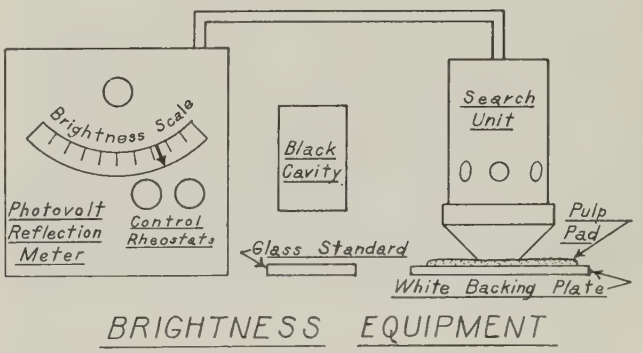
The sample pad is read on the Photovolt, using a standard white background. It is necessary to use a standard background because variation in the background brightness will affect the brightness result by as much as several points. The sample pads are not thick enough to eliminate background reflectance. Therefore, the background must be the same brightness for all tests to assure comparable results.

FOUR-MINUTE VERSUS 15-MINUTE TEST

After the 4-min. Photovolt method was developed, a series of tests were run to determine how brightness values by this



(a)



(b)

Fig. 3

method compared with the 15-min. Longview method. From 15 to 20 tests were run on each grade of pulp. Each test consisted of a 4-min. and a 15-minute test on the same sample.

It was found that the 4-min. method gave the same brightness as the 15-min. method on stock in the 80 or above range. It gave 0.5 point lower on stock in the 65 to 75 brightness range. This slight difference does not lessen its value as a bleaching control, as one merely lowers the brightness control range 0.5 point on washers operating in the 65 to 75 range. It is believed that the 0.5 loss is caused by a slight browning of the impurities in the stock. Stock bleached to 80 brightness or higher hasn't sufficient impurities left to show appreciable browning in the 4-min. drying period.

PHOTOVOLT AND G.E. MACHINE BRIGHTNESS

There were conflicting opinions as to whether or not the Photovolt test would indicate machine brightness. The Photovolt would have to be related to machine brightness to be used as a bleaching control. To check for correlation the Photovolt brightness on no. 4 bleached washer and the corresponding G.E. machine brightness were averaged for each shift for one month. The machine brightness was taken 8 hr. after the no. 4 washer brightness, so both brightnesses would be on about the same stock.

The shift averages were plotted for no. 4 washer and the machine. In order to make correlation easier to see, a moving average of three values was plotted (see Fig. 2). Also, the machine values were shifted down to bring the curve closer to the no. 4 washer curve. This makes a visual comparison of the two curves easier.

The similarity of the curves in Fig. 2 shows that the photovolt brightness on no. 4 washer will be indicative of the machine brightness to follow. There are some bobbles in the correlation; this is to be expected. The time interval between no. 4 washer and the machine varies from the 8 hr. value used—which would account for some discrepancies between the curves. Broke put back into the system will change the machine brightness with affecting 4 washer. Also, the total brightness fluctuation is so small that testing error can camouflage the true trend and cause apparent noncorrelation.

The Photovolt test does not give a brightness equal to the G.E. on these semidry pads, but it is relative to it. The ratio varies for different grades of pulp; for example, an 83 Photovolt on one grade gives an 86 G.E.; on another grade it may take an 84 to get 86 G.E.

CONCLUSIONS

From the foregoing data it can be concluded that this quick Photovolt brightness test will serve as a dependable bleaching control and will indicate the brightness to be expected on the machine. The 4-min. test gives the same brightness as the 15-min. test on pulp of 80 or higher brightness. It runs about 0.5 points low on pulp in the 65 to 75 range.

Presented at the meeting of the Pacific Section of TAPPI held in Aberdeen, Wash., Jan. 20, 1959.

Improved Procedure for Estimation of Certain Sulphur Compounds in Kraft Pulp Mill Effluent Streams—Abstract

Vincent F. Felicetta and Joseph L. McCarthy

Several years ago the authors published in *Tappi* a scheme for analysis of hydrogen sulphide, methyl mercaptan, dimethyl sulphide and dimethyl disulphide in kraft pulp mill process streams including digester relief gas, digester blow gas condensates, evaporator condensates and recovery furnace stack gas. Recently the methods have been improved mostly by elimination of interference from unsaturated materials and in the procedures for estimation of dimethyl sulphide and dimethyl disulphide.

Gaseous or liquid samples are permitted to partition between aqueous sodium hydroxide and carbon tetrachloride. The salt formers, H_2S and CH_3SH appear in the aqueous layer whereas the substantially water insoluble $(CH_3)_2S$ and $(CH_3)_2S_2$ dissolve in the carbon tetrachloride layer. Hydrogen sulphide and methyl mercaptan are determined individually by a potentiometric titration. Dimethyl sulphide and dimethyl disulphide are partially separated by simple distillation, the unsaturated compounds in the distillate and distilland are prebrominated and the sulphur compounds are then measured by titration with bromate-bromide reagent. Alternatively, and when only small amounts of dimethyl sulphide are present, the latter is measured spectrophotometrically after formation of an iodine addition compound.

Vincent F. Felicetta, Research Assistant Professor, and Joseph L. McCarthy, Professor, University of Washington, Seattle, Wash.

Testing the Printability of Pulps

J. H. Baxter

In selecting pulps for use in printing grade furnishes, a test is needed which will numerically classify pulps as to printability. This should be accomplished instrumentally so that the human variable is eliminated as much as possible. The test, applied to the available pulps, would assign a printability number to each, which could be a criterion in selecting or rejecting them.

The Vandercook proof press has been used to test printability of paper (*1*), the prints being judged visually. To accomplish an instrumental grading and eliminate the human judgment factor, our test employes the Bausch and Lomb opacimeter in evaluating prints.

PREPARING THE SAMPLES FOR PRINTING

In preparing to run the test, handsheets of the pulps to be tested are made, supercalendered, and cut into sample strips. The strips are mounted on a backing sheet ready to be printed.

Handsheets are formed in a standard British sheet machine to a moisture-free weight of 1.25 g. After supercalendering, these handsheets have a caliper of approximately 0.003 in. The backing sheet, on which the samples are mounted, has an equal caliper, so that backing sheet and sample together caliper 0.006 to 0.0064 in. The proof press is packed for this thickness. A standard amount of supercalender treatment is given to the sheets. This should be enough to smooth the surface and produce some gloss. The supercalendered sheets are cut into strips about 1 in. in width before being mounted side by side on the backing sheet.

A strip of book groundwood which has been made up in the same manner as the other samples is attached to each backing sheet, to be used as a printability reference for the samples.

Also, on each side of the backing sheet a control strip, consisting of a 1-in. strip of the same paper as the backing sheet, is fastened. This will be used to determine whether printing pressure has been uniform across the plate.

Care is taken to see that all strips are mounted wire side down.

PREPARING THE OPACIMETER AND PROOF PRESS

The Bausch and Lomb opacimeter is zeroed in the standard way so that it reads 0 on the black body and 10 on the white body.

The proof press is inked and enough prints run off so that the desired ink level is reached. The proof press should be equipped with a fairly wide plate, about 10 in. This allows for seven sample strips to be printed at one impression. The

J. H. Baxter, Crown Zellerbach Corporation, West Linn, Ore.

plate must have a solid printing bar, which is the area that is read by the opacimeter.

About $1^1/_2$ cc. of black proof press ink are applied to the press rolls and allowed to distribute. Then sufficient impressions are made to bring the ink level to the point at which a reading of 0.9 to 1.0 is read on the opacimeter. For this reading the solid printed area is backed by the white body.

PRINTING AND READING THE SAMPLES

After printing, the ink is allowed to dry, before the samples are read by the opacimeter. A reading taken on the printed area is referred to one taken on the unprinted area by using the formula:

$$10 \log \left(\frac{\text{unprinted area reading}}{\text{printed area reading}} \right)$$

The resultant numbers allow the sample pulps to be numerically compared to the groundwood standard. When the groundwood standard is raised to 100, the numbers for the samples tested are raised accordingly giving the standard printability numbers for the pulps tested.

DISCUSSION

When used judiciously and with careful attention to sample preparation and printing, the test will give reliable results. It has been proved in practice that pulps with high printability test numbers form better-printing machine-made papers than do pulps with lower printability numbers.

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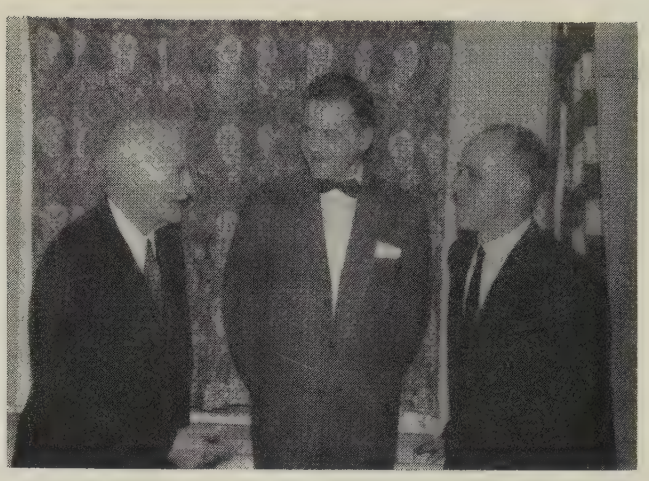
Presented at the meeting of the Pacific Section of TAPPI held in Aberdeen, Wash., Jan. 20, 1959.

Delaware Valley

The Delaware Valley Section of TAPPI sponsored Graphic Arts Conference was held at the Engineers Club, Jan. 22, 1959, with the cooperation of the Philadelphia Printing Ink Makers Production Club, and the Philadelphia Club of Printing House Craftsmen, Frederic Dannerth, technical advisor to the graphic arts industry, being the special chairman for the conference.

Exhibits of papers for offset and letterpress printing illustrating the art of printing were presented in the afternoon.

Panel at the Philadelphia Graphic Arts Conference—G. E. Hess, Franklin Printing Co.; J. F. Krause, R. W. Rexford Co., Inc.; L. C. Radtke, Hopper Paper Co.; W. J. Arader, Edward Stern & Co.; Morris Garrick, McCutcheon Bros.; Howard Ferguson, Curtis Paper Co.; H. Seeburger, of Arndt, Preston, Chapin, Lamb and Keen, Inc.



Frederic Dannerth, technical advisor to the graphic arts industry; John Kratz, of the printing industry of Philadelphia, and Harry Seeburger, moderator of the evening's panel discussion

Dinner was served at 6:00 p.m., and the Graphic Arts Conference opened at 8:00 p.m.

George Boger, vice-chairman of Delaware Valley Section of TAPPI, opened the meeting and introduced the special conference chairman for the evening—Dr. F. Dannerth.

Dr. Dannerth, then introduced John B. Kratz, vice-president of Printing Industries of Philadelphia. Mr. Kratz mentioned to us some of the jobs his organization does for the industry, such as education, watch dog for industry, etc.

Harry Seeburger, of Arndt, Preston, Chapin, Lamb, and Keen, Inc., was introduced and he took over as moderator for the program.

The following are discussions of printing problems given by two ink representatives, two paper representatives, and two printing representatives.

A question and answer session followed, and the meeting closed at 10:00 p.m.

L. H. Smaine, *Secretary*

Howard Ferguson (Curtis Paper Co.)

My part in the program this evening is "Paper Made for Letterpress Printing" and I suppose the $64.00 question is what is a good letterpress sheet? Before attempting to answer that question, I think a brief description of the various

M. Garrick of the Printing Ink Club, G. K. Boger, program chairman of TAPPI, and R. G. Phyle, of the Printing House Craftsmen's Club—chairmen of the evening

pulps produced, the type of beating and necessary paper machine adjustments required to make a letterpress sheet would be in order.

Starting at the bottom of the list would be groundwood pulp which I do not believe we want to consider in our high-grade sheet, as it is mostly used in newsprint and that sheet is made for a short period of service and easy disposal.

Next in line would be old papers, deinked stock, and reused stock and again we will not consider old papers.

Soda pulp: this grade would definitely be an important ingredient. This pulp is made from hardwood trees, such as poplar, birch, beech, etc. These trees have a very short fiber and the caustic cook separates the fibers very readily, leaving them soft and bulky.

Bleached sulphite would be next and plays an important part in the make-up of the sheet. The trees used to make this fiber are in the evergreen family, such as the spruce, hemlock, pine, etc. The cook generally used on this grade of pulp is lime and sulphurous acid. This pulp is known as having a long fiber with good strength.

The bleached kraft could be used where an exceptionally high fold would be required, but normally the pulp would be too hard and strong for letterpress.

The alpha-cellulose pulp differs from the other pulps in that it is strong with good fiber length, yet very soft and flexible. It is also a very pure product, having had practically all the lignins, resins, and other impurities removed and is ideal for letterpress papers.

Last but by no means the least would be the rag fiber. We will not use any rags in our letterpress sheet, not because a nice, soft rag wouldn't make a beautiful sheet, but the price would probably make it prohibitive for general letterpress consumption.

The beating plays an important part in the final results of the sheet desired. First, or course, would be the beater furnish which would be the selection of the combination of the pulps. A good amount of soda pulp should be used as it has a short fiber and is soft and bulky and when blended with other fibers will tend to fill in the low spots in the sheet. Some alpha-cellulose should be considered, as this pulp has a strong fiber; in addition, it is soft and flexible and will help the pliability. Then the balance of the furnish made up of bleached sulphite: this will give the sheet the necessary body and strength to make it a serviceable product. Very little rosin size should be used, as ink receptivity is very important. An unusual amount of loading can be used. Clay is generally the filler used and it will tend to level out the sheet, filling up the valleys. It is also very receptive to inks.

Titanium is used in all good white letterpress sheets for brightness and opacity.

The beating time required for letterpress is short, as you do not want to hydrate the fibers too much or you are apt to get a rather hard and tinny sheet, even with the above-mentioned furnish and that would be undesirable for letterpress quality. However, you do want to develop fibrillation, which is the fraying of the fibers so that they will adhere to one another in the formation of the sheet on the paper machine wire. The beating cycle should be of short duration with a good, stiff brush. In paper mill terminology, this means the position of the beater roll to the bedplate and this may differ from paper mill to paper mill, but the personnel of each mill will have that under control.

Now, we have the furnish and the beating. Next would be the actual making of the sheet on the paper machine. Because of the type of pulps selected and the short beating cycle, we have very free stock. So more water is required at the headbox to aid in the formation as the water leaves free-stock much more readily than slow stock. The extra water is needed to carry the stock down the wire so that you can take advantage of all your forming area.

The right amount of shake on the wire is very important, as this has a very definite bearing on the construction of the sheet as well as the formation.

No surface sizing is required; however, many mills will put the sheet through a very dilute solution as this tends to flatten out the surface of the paper.

Some machine calendering is good as this also helps to eliminate the hills and valleys and should reduce some of the pressure on the printing press.

Now, assuming that the surface of the sheet is clean, having no lint, dirt or foreign particles, no torn or wrinkled sheets, perfectly flat without any curl, we should have a good, uncoated letterpress sheet. I understand coated papers are used quite extensively for letterpress printing, particularly for solids and halftones, but we do not make coated paper at our mill, so I am not qualified to discuss this type of paper.

To sum up my remarks as to what makes a good, uncoated letterpress sheet: a soft, bulky pulp with enough long, strong fibers to hold the sheet together; very little rosin size; heavily loaded; short beating cycle; necessary water on paper machine; right amount of shake on the machine wire; a very dilute surface sizing and some machine calendering.

I hope I have answered that $64.00 question.

Morris Garrick (McCutcheon Brothers)

I would first like to pay tribute to the special chairman of this event, Dr. Frederic Dannerth of TAPPI and his committee, who did most of the leg work and organizing to make this meeting a reality. As a representative of the Philadelphia Printing Ink Makers Production Club, I would like to say that we welcome this opportunity for a forum at which printers, papermakers and inkmakers can discuss the various problems they each encounter in their day to day work. This type of interchange can only lead to better understanding of our mutual problems.

I know as an inkmaker, that many times I encounter a problem which is hard to understand until you get down to the basic facts. With many new ingredients going into paper, we all need to know about these changes. Small additions of a new ingredient to a paper stock furnish or coating may change the absorbency and ink receptivity of that paper. Then the printer, not knowing of the change may use the same ink as last used on the job and get different results as far as bind, rub, offset, etc. I ran across a case in point recently—on a solid fiber board. The ink made for this job worked well for two orders. Then on the third order, something went wrong. When finally the truth came out, it was found that on the first two boards 2% urea-formaldehyde was spread throughout the four or five liners. On the third board, the paper manufacturer put 2% urea-formaldehyde in the top liner. This sealed the board and caused all the problems. The paper man thought he was helping but did not let the printer know about the change. The job was in a rush and the ink had been ordered in advance, expecting the same stock.

Another example might be the new bright stocks being put out. All of a sudden, some lithographers in the area began to complain about slow drying of inks on so-called "titanium" stocks. When the problem was examined further, it was apparent that it was more than just the use of titanium dioxide filler that was causing the troubles. The paper was examined under ultraviolet light and a bright fluorescence was noticed. The paper people were putting optical brighteners in the papers. When they did this, they must not have been aware that these brighteners were also drying retarders. Once this was understood, the problem was resolved.

My point is that there must be constant communication between the papermaker, the printer and the inkmaker. It is pretty hard to see in the darkness, but in the full light of day created by full communication and discussion, many of the problems are more easily understood. We all stand to gain from this.

Walter Arader (Edward Stern & Co., Inc.)

Discussion on problems in offset printing. The following is the procedure used at Stern Bros.:

1. A form is attached to the incoming paper—each shipment which includes the following: (a) tightness of wrappers, (b) where and for what job paper is assigned, (c) size and basis weight, (d) relative humidity.

2. Paper reaches press and is ready for printing and additional information is recorded: (a) process paper is to be printed, (b) ink coverage, (c) loose dirt, curl, waves, wrinkles, pick, size, ink receptivity and any other additional information of importance.

By the use of these forms, background for processing claims can be made—the printer always loses on a paper claim; the complaints are sent out primarily to let the paper mill know how they are doing. Most are not dollar claims.

J. Krause (Rexford Printing Inks)

The formulation and manufacture of printing ink today is a highly complex science, as contrasted with the secret and rigid art of yesteryear. However, on much too many occasions, it is a hit or miss proposition, because of the hurried, last minute requests that ink makers are constantly plagued with, from day to day.

Because of these demands and for all of the harassments, printing ink manufacturing has grown and developed into a highly specialized service selling business. In fact it is one of the few industries I know where technology, at a high level, is available on a made-to-order-while-you-wait basis.

The average ink manufacturing firm, as a result, has to maintain very flexible operating schedules in order to successfully fulfill its obligations to its customers.

We are called upon, all too frequently, to produce inks that must match all sorts of copies and wet samples, exactly, in varying qualities of finish, drying speed, and resistance requirements, for all types of printing equipment, on all kinds of white and colored paper stocks, cloths, metals, foils, plastics or what have you sometimes in a matter of minutes or at the most, in a few hours, without sufficient or any of the materials on which to even do superficial testing. And at a nominal cost and occasionally in less than 1-lb. quantity lots to boot.

The impossible requests, of course, are always rationalized after sometimes long and extended explanation and discussion with the principles involved, but in too many cases, ink makers bend over backwards too far in their efforts to help a printer expedite a rush job that oftentimes does not prove satisfactory.

I am only repeating what has too often been stated before, that in order for inkmakers to produce less troublesome and better working inks, they must be supplied with all the information possible, regarding the nature and end use requirements of the job to be printed, type of printing equipment to be used, samples of the actual stock to be run and sufficient time to conduct tests and manufacture the ink.

There is a saying in the trade which poses this question. "Why is there time to do it over and not enough time to do it right?" In pursuing this thought we have formed a policy in our plant to discuss mad rush jobs with our customers and have found the greater majority to agree to an extension of time, when the hazards involved were laid bare. As a result of this policy we have cut down our service calls from a high of 20% to a low 2% average. We and our customers feel that the extra time needed to get the ink right is worth the many hours of lost pressman's time fussing with the ink and still many more hours of our time servicing or reformulating it.

There are so many factors which determine how an ink is to be properly formulated that there is not enough time to review them here because of the limited scope of our program. To attest to the many variables affecting formulation, for example, it has been estimated that roughly between 50,000 to 75,000 new formulations are produced by the ink industry every month. I think this is a conservative estimate at that.

However, since this is a paper-and-ink inspired gathering, a few specific examples, outlining the importance of stock, in the production of higher quality inks, for better printing, is quite in order.

The single factor that accounts for many printing, drying and off-color difficulties encountered in printing is failure on the part of the printer to supply the ink maker with the *actual* stock to be used with the ink ordered for the job.

In too many instances, a printer will ask us to make the ink for any regular coated, bond, or offset paper that we may have on hand and if we insist on his sample of the stock, he may send us something similar that he has on his premises because more than likely the stock ordered for the job had not yet arrived at his plant. Too many printers consider unimportant or are even unaware of the variations that exist, not only in similar types of stock, but also in different batches of the same brand stocks.

The whiteness variations of stocks, for example, run into unbelievable numbers. It has been stated that there are close to a million shades or tints of white and I sometimes think they all exist in paper alone, although this may not be the case. However, the existing variations do cause considerable trouble in the reproduction of a matched color, particularly where pastel tints are concerned. For example, whiteness variations in two given stocks can alter a pastel blue anywhere from an ultramarine to an aquamarine hue.

The aging characteristics of a paper, which turn it to the yellow and dirty side, plus the yellowing action of the vehicle portion of the ink, causes a further drift in color, when a job is re-run months or even weeks later. Explanation of this phenomena does not always carry enough weight with the printer or buyer and invariably the ink is changed to match the old copy time and again, with the usual resultant loss of time and money to the ink maker and printer as well.

The absorption characteristics of stocks also vary to a considerable degree, resulting in color differences, mottled effects, drying irregularities, lower or higher finish and gloss and ink consumption or so-called mileage discrepancies.

Surface strength or pick resistance variations of stocks may dictate not only the reduction of the viscosity or tack of an ink, but may require the complete reformulation of a particular standard ink to one based on softer and/or harder drying vehicles.

Our club's Technical Committee's report on "the evaluation of waxes in printing inks" and their effects on film reinforcement, to be released for publication shortly, has disclosed that differences in coated stocks have much to do in altering the rub resistance properties of a given ink.

Surface uniformity and hardness variations of stocks, particularly the index types, are responsible for many drying, offsetting and uneven printing difficulties. Hard and soft spot irregularities of these hard calendered coated or uncoated stocks have necessitated shifting from conventional or gloss to absolutely dull or matte inks and the added costs of after-varnishing in order to obtain smooth even film effects. In other cases complete opacity must be incorporated in an ink to hide or cover the sins of the stock.

In many instances, inkmakers have detected certain deficiencies of stocks, in the course of their proofing operations, that have actually resulted in the savings of many dollars, not only to the printers but to the papermakers as well. In some cases papers were replaced or pretreated by sizing before the actual printing was undertaken. In others, inks were altered to suit the stock or different methods of printing were substituted to bring about the desired results.

Some of the variables due to paper and ink that might possibly lead to serious trouble could be forestalled by the printers themselves by test running a new shipment of paper or ink on the tail end of a run or the end of the day. Even a simple pat out of the old and new ink on the old and new

batch of stock can indicate much to help the printer avoid aggravation and lost time.

In summing up, one might assume from the foregoing that the papermakers and printers, and not the inkmakers, are responsible for the existing troubles in the printing industry. This, of course, is far from the truth. This presentation, although only skimming the surface, has been made from our side of the fence to point up some of the variables that should be considered impartially and carefully if we are to make any headway in minimizing the difficulties in our industry. Our growth is a living testimonial to the skill and knowledge we have acquired through the years. All of this can be attributed to whole hearted cooperation and a desire to understand each others technology and its problems. But this is not enough. We must re-appraise and re-emphasize the existing faults in our industry and bring them out into the open if we are to continue this rate of growth. It is through the medium of such gatherings as this that the goals we seek can best be reached.

I sincerely hope that each of us can leave here tonight richer in knowledge, because in this expanding age of technology, we can't get along no how, without know how.

***L. Radtke* (*Hopper Paper Co.*)**

I'd like to confine my remarks this evening to the printing surface of uncoated offset paper.

Naturally, paper surface has an effect on printing results and that is possibly the reasons we have different paper surfaces such as textured or embossed finishes, antique, vellum finished paper, smooth finish and supercalendered surfaces. When lithography was in its infancy it was generally conceded that a toothy antique or porous-type printing surface was a necessity for quick drying and less offsetting. During the early 30's when the Hopper Paper Co. first began producing offset papers in quantity we considered a printing surface that would withstand no. 8 or a no. 10 Dennison wax test as excellent and so did the lithographer. Today, we would not allow a sheet of offset paper out of our mills, intentionally, that is, if the surface would not withstand a wax test of 13 or better.

Since World War II the surface and printability of offset papers has changed tremendously. The present-day lithographer requires a paper with a better bonded surface because he uses more tacky inks to gain better reproduction. His equipment is larger and faster, consequently more and more is being required of the sheet of paper he uses.

The paper industry and, more specifically the offset paper group of the Book Paper Manufacturers Association are extremely conscious of the demands placed on offset paper. During the past several years the offset paper group inaugurated some exhaustive printability tests jointly with The Institute of Paper Chemistry in Appleton, Wis., and the Lithographic Technical Foundation in Chicago and New York. The purpose of these tests, and if I remember correctly I believe there were four or five of them, was to test many different offset sheets in the laboratory and then try to use these tests in predicting the behavior of offset paper on the printing press. In making these tests it was necessary to go to a great deal of effort on the part of The Institute of Paper Chemistry and Lithographic Technical Foundation, so as they could test all papers under similar conditions. This was a tremendous undertaking in a coordinated effort to try to correlate the lab tests of offset paper properties and try to measure the printability of a sheet. It was pretty well conceded that under practical conditions there is a considerable inter-relationship between paper properties and therefore most difficult to find a common denominator or a measuring stick to predict with any degree of accuracy the behavior of offset papers on an offset press.

Time does not permit me to go into all phases of the printability tests, however we use a term "print quality factors" that I would like to discuss with you at this time. By "print quality" we mean just how much will the paper surface contribute to the grainy appearance of the image, will the halftone detail appear soft or sharp, will the solids appear smooth or mottled, etc.

The first print quality that I think deserves mention is graininess. When an image on a completed offset sheet appears grainy, and the graininess is caused by paper, it is believed to be due to the irregularity in the surface smoothness and absorbency which is the function of the fiber the way they are treated before the sheet is formed, and the distribution of these fibers in the sheet. If a lithographer is to print a job containing fine screen halftones he will want to select the paper that will have a low degree of surface graininess. Conversely, if a lithographer is going to print a very coarse screen halftone such as poster work, graininess will have little or no import. At this point I think it may be well to point out that graininess is not the same thing as a toothy antique or vellum finished sheet, but rather graininess is probably an imperfection in a vellum or antique sheet or on any surface. After all, I am sure many of the people in this room have printed some very excellent fine halftones on vellum and antique sheets providing the surface was uniform. Another thing that may be mentioned here, but is not the same thing as graininess, is the mottled effect that you may get on solids. This is usually the result of uneven ink absorbency and as a result, you will get galvanized effects in the solid areas. This can be caused by a sheet with poor or wild formation. When such a sheet is passed through the calender stack the high spots are hit so hard they become glossy and therefore less absorbent than the other portions of the sheet that have been hit less hard.

Acuteness is our no. 2 quality factor. By acuteness we mean sharpness of detail or how well can a trained observer resolve the detail in a press sheet. The extremes of sharpness can easily be seen by comparing a half-tone image on a mediocre grade of newsprint with the same half-tone image on a good, well formed sheet of offset paper. Again, if a lithographer is printing a job where he is carrying a great amount of detail he will want to select the uncoated sheet with a high acuteness rating. In the Hopper offset manufactured by my company we build this into the sheet in such a way that when you apply ink to the surface of the paper the ink pigments will stay on top of the sheet rather than drying by absorption and thus you will get a much clearer reproduction. Any time a sheet dries mostly by absorption you will get faded out appearance that no one likes.

Our third print quality is "tone reproduction." Tone reproduction refers to the relationship between the tone or density of corresponding areas in the original and in the press sheet image. We know that tone reproduction between the original and the press sheet is primarily determined by the half-tone transparency plate and press, however it is also affected by the physical properties of the paper. Some papers will give full images in the production of halftones while others will give lighter or thin images. This effect is due to the internal light scatter in the paper and this can be gaged by measuring the reflection density of a 70% tint. The higher density, the greater the internal light scattering in the paper sample. Tone reproduction is also important to the lithographer in the rerun of a job. Suppose the job is rerun with the same press plates but the paper is changed from one of low to one of high 70% density. In the reruns the halftones will appear much fuller and darker than the original run and this is particularly true in process color work. Therefore, in rerun work, it is always desirable to match the graininess and sharpness of a sheet as well as the paper in general. Unfortunately, it is not feasible to show actual press sheets in a gathering such as this to illustrate the print quality factors that we have discussed. However, I wanted to point out some of the things that should be taken into consideration by all who purchase paper and particularly paper surfaces.

George Hess (Franklin Printing Co.)

Imperfections in letterpress printing always shows up on the paper.

By the use of soft inks, the printer could get away with less make ready.

We all need better coordination throughout the industry, forget about the past, and seek new ways and methods. There is a need for more measurement and testing of paper and ink quality.

Following are qualities needed in ink: finish, good print on solids, good coverage, penetration, minimum strike through, clear transfer and no offset.

Discussion

1. Do printers take uniformity of paper for granted?
   No, but the only way known to test for this is actual printing of the paper.
2. How do you print wavy edge paper?
   Cut out packing; put bank of heat lamps on skids before use and also during the feeding.
3. What is cause of misregister in 3–4 color job offset?
   There is no one answer to this problem—the press, ink, paper, etc., all could cause misregister.
4. Is paper trimmed accurately enough for tumbler forms?
   Yes, generally speaking.
5. Could the water transfer from press to the sheet change Relative Humidity of the sheet?
   Possibly on a soft offset sheet.
6. Are there any troubles on press (offset) from use of titanium dioxide?
   Not specifically.
7. Why do printers specify paper on skids to be felt side up?
   There is no preference for paper to be felt side up—however felt side is usually considered the best printing surface.

Southeastern

The first meeting of the Southeastern Section for 1959 was held at the General Oglethorpe Hotal, Savannah, Ga., on January 23. Union Bag-Camp Paper Corp. was host mill. Three papers were presented at the dinner meeting on Friday night. D. W. Reid of the Savannah mill of Union Bag-Camp gave the first paper intitled "Standardization of Mullen Testers." This paper was substituted for the programmed paper by P. E. Wrist of the Mead Corp. of Chillicothe, Ohio. Mr. Wrist was unable to attend because of a flood which covered much of the mill property at Chillicothe. The second paper was by J. D. Robertson of the Sonoco Products Co. at Hartsville, S. C. Mr. Robertson's paper was entered in the Awards Content. It was entitled 'Concentration of Neutral Sulphite White Liquor as a Function of Wood Temperature and Wood Moisture." The third and main speaker of the evening was Wilfred Gallay of the E. P. Eddy Co. of Canada. Dr. Gallay spoke on "The Development of the Strength of Paper." Over 170 attended the dinner-technical meeting.

On saturady morning two mill tours were open. The American Cyanamid titanium dioxide pigment plant and the Herty Foundation Laboratory were open for inspection.

In a business session the Section agreed to enter two projects which will be of general interest to the area. The Section will sponsor an essay contest in the junior and senior high schools of the area with the topic to be about some phase of the pulp and paper industry. Prizes are to be awarded in this contest. It was also agreed that the Southeastern Section would present to the principal colleges and universities of the area and to the public libraries in the cities or towns where mills are located a set of books pertaining to the industry.

A nominating committee to select a list of candidates as officers for the next year was appointed. J. R. Luntz will serve as chairman of the committee. Other members are V. F. Waters, W. L. Belvin and Bruce Ellen.

J. B. Doughty, *Recording Secretary*

Concentration of Neutral Sulphite White Liquor as a Function of Wood Temperature and Wood Moisture

Julius D. Robertson

Wood temperature and wood moisture are important variables in the digestion of wood to produce pulp. Both of these variables directly influence the quantity of steam condensed in heating the charge to pulping temperature. Low wood temperature and high wood moisture result in excessive dilution by condensate in the digester.

The law of mass action states that the velocity of a chemical reaction is proportional to the molar concentration of the reactants. The basis of the neutral sulphite pulping process is a chemical reaction between sodium sulphite and lignin to form sodium lignosulphonate. This very mild reaction is quite sensitive to changes in velocity actuated by condensate dilution. A constant reaction velocity is imperative in continuous neutral sulphite pulping, in which short residence time in the digester demands rigid control of digester concentration.

Control of digester concentration is synonymous with control of liquor to wood ratio and reaction velocity. Rate of delignification is dependent on such control. Liquor to wood ratio and reaction velocity can be most logically controlled by making white liquor concentration a function of wood temperature and wood moisture.

The quantity of heat required to bring the digester charge to pulping temperature is determined by the quantity and specific heat of the ingredients, the temperature differential to be effected in each, and the radiant heat loss of the system. The release of heat involves condensation of steam. The quantity of steam that must be condensed to release the desired amount of heat is governed by the latent heat of steam at maximum pulping temperature.

The calculation of a heat and materials balance in a neutral sulfite digestion is dependent on the conditions under which the digestion is conducted. Factors that may be considered as predetermined constants are sodium sulphite to wood ratio, carbonate buffer to sulphite ratio, temperature of the white liquor, radiant heat loss, and liquor to wood ratio. Factors that should be treated as variables are wood temperature, wood moisture, and white liquor concentration.

An equation can now be derived, in which white liquor concentration is expressed as a function of wood temperature and wood moisture.

An equation has been derived, expressing white liquor concentration as a function of wood temperature and wood moisture. It is concise formula, based on established procedures for calculating heat and materials balances in digesters. The use of this equation to determine white liquor

Table I. Constants and Variables

Pounds moisture-free wood (basis of calculation)	1.0
Ratio, water in wood to moisture-free wood substance	Y
Ratio, Na_2SO_3 to moisture-free wood substance	P
Pounds Na_2SO_3 per cubic foot of white liquor	X
Cubic feet white liquor per pound moisture-free wood	P/X
Ratio, carbonate buffer as Na_2O to Na_2SO_3	A
Pounds carbonate buffer as Na_2O per cubic foot white liquor[a]	AX
Pounds water per cubic foot white liquor (approximate)	62
Pound weight, one cubic foot of white liquor	$62 + X + AX$
Ratio, white liquor to moisture-free wood	$P(62 + X + AX)/X$
Specific heat, inorganic salts in white liquor (approximate)	0.26
Specific heat of white liquor	$(62 + 0.26X + 0.26AX)/(62 + X + AX)$
Specific heat of moisture-free wood substance	0.33
Temperature differential, heating wood, °F	Dw
Temperature differential, heating white liquor, °F	Ds
Liquor to wood ratio at pulping temperature	C
Latent heat of steam at pulping temperature, B.t.u./lb.	L
Condensate, radiant heat loss, per pound moisture-free wood	R

[a] Carbonate ingredient of the white liquor loses CO_2 very early in the heating cycle.

Julius D. Robertson, Sonoco Products Co., Hartsville, S. C.

Table II. Heat and Materials Balance, Basis = 1 Lb. Moisture-free Wood

Pounds condensate, radiant heat loss	R
Pounds condensate, heating moisture-free wood	$\frac{0.33D_w}{L}$
Pounds water in wood	Y
Pounds condensate, heating water in wood	$\frac{D_wY}{L}$
Pounds white liquor	$\frac{P(62 + X + AX)}{X}$
Pounds condensate, heating white liquor	$\frac{PD_s(62 + 0.26X + 0.26AX)}{XL}$
Total	$R + \frac{0.33D_w}{L} + Y + \frac{D_wY}{L} + \frac{P(62 + X + AX)}{X} + \frac{PD_s(62 + 0.26X + 0.26AX)}{XL}$

DERIVATION OF EQUATION

$$C = R + \frac{0.33D_w}{L} + Y + \frac{D_wY}{L} + \frac{P(62 + X + AX)}{X} + \frac{PD_s(62 + 0.26X + 0.26AX)}{XL}$$

$$CXL = RXL + 0.33D_wX + XYL + D_wXY + 62PL + PLX + APLX + 62PD_s + 0.26PD_sX + 0.26APD_sX$$

$$XCL - XRL - XYL - 0.33D_wX - D_wXY - PLX - APLX - 0.26PD_sX - 0.26APD_sX = 62P(L + D_s)$$

$$X = \frac{62P(L + D_s)}{L(C - R - Y) - D_w(0.33 + Y) - PL(A + 1) - 0.26PD_s(A + 1)}$$

$$X = \frac{62P(L + D_s)}{L(C - R - Y) - D_w(0.33 + Y) - P(L + 0.26D_s)(A + 1)}$$

concentration will insure better control of the neutral sulphite pulping process and better product uniformity.

EXAMPLE

A neutral sulphite plant desires a liquor to wood ratio of 3.0. They cook with 10% Na_2SO_3 based on moisture-free wood, and maintain a ratio of carbonate buffer, as Na_2O, to sulphite of 0.20. Maximum digester temperature is 364°F. White liquor temperature is 140°F. Predetermined radiant heat loss amounts to 200 lb. per ton of moisture-free wood charged to the digester. Examination of the chip supply

C	= 3.00
P	= 0.10
A	= 0.20
Y	= 1.0
$R = 200/2000$	= 0.10
L (364°F.)	= 859
$D_w = 364 - 60$	= 304
$D_s = 364 - 140$	= 224

$$X = \frac{62P(L + D_s)}{L(C - R - Y) - D_w(0.33 + Y) - P(L + 0.26D_s)(A + 1)}$$

$$X = \frac{6.2(1083)}{859(1.90) - 304(1.33) - 0.10(917)(1.20)}$$

$$X = \frac{6715}{1632 - 404 - 110} = \frac{6715}{1118} = 6.01 \text{ lb. } Na_2SO_3 \text{ per cubic foot}$$

reveals a temperature of 60°F. and a ratio of water to moisture-free wood of 1.0. What must the concentration of the white liquor be to maintain the desired liquor to wood ratio of 3.0?

Presented at the meeting of the Southeastern Section of TAPPI held in Savannah, Ga., Jan. 23, 1959.

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A Bibliography of Alkaline Digester Corrosion

1958 Supplement

RICHARD B. KESLER

Doe, R. W. Operating Experiences in a Neutral Sulphite Semichemical Pulp Mill. *Paper Trade J.* 141, No. 47: 35–37 (Nov. 25, 1957).

Problems in barking, wood handling, refining, washing and thickening, bleaching, and digester corrosion, which were encountered in the operation of a neutral sulphite semichemical pulp mill utilizing hardwoods, and their solutions are outlined. Carbon steel rotary digesters were found to be attacked at an alarming rate. Spray metal coating (stainless steel) solved the corrosion problem.

Digester Overlays. *Pulp & Paper* 32, No. 2: 80–81 (February, 1958).

The Alloy Cladding Co., Baltimore, Md., has developed a continuous automatic method and apparatus for welding digester overlays. The equipment has been successfully employed in overlaying kraft digesters in a southern mill. The welding head of the apparatus is mounted on an operating platform on top of a circular track for rotation through 360° and is indexed for proper vertical movement. The arc is maintained at a set distance from the digester walls during rotation. Granulated welding flux for the submerged arc process is fed from hoppers by gravity and recovered by a vacuum system. Bare stainless-steel electrodes are fed from a reel to the welding head. Operation is entirely automatic through the length of the vertical indexing mechanism or until the materials have been consumed.

Hopper, E. W. Kraft Mill Extends Digester Life. *Pulp & Paper* 31, No. 10: 61–63 (September, 1957).

At the Covington, Va., mill of West Virginia Pulp & Paper Co., the costly corrosion of carbon-steel kraft digesters was remedied satisfactorily by the application of welded-on stainless-steel overlays in the thinned areas.

Kesler, R. B., and Bakken, J. F. Corrosion of Mild Steel in Alkaline Pulping Liquors. I. Kraft White Liquor. *Tappi* 41, No. 3: 97–102 (March, 1958).

The effect of the presence of appreciable quantities of sodium chloride, sodium sulphate, and sodium carbonate in kraft white liquor on the corrosion rate of mild steel in white liquor was investigated. Two experimental methods were used—weight-loss tests and polarization curves. The results of weight-loss tests were correlated with the "corrosivity" of the liquor (i.e., the diffusion rate of polysulphide ion to the metal surface), using Bernt Roald's corrosivity equation (I). The applicability of (I) was found to be limited to liquors containing more than 1 g.p.l. of sodium sulphite. When (I) is not applicable, the effect of the three chemicals was found to be negligible or mildly inhibitive toward corrosion. In liquors to which (I) could validly be applied, the three chemicals appeared to cause increased corrosion with increased liquor corrosivity. The results obtained by weight-loss tests were substantiated by polarization curves.

Kesler, R. B. Corrosion of Mild Steel in Alkaline Pulping Liquors. II. Neutral Sulphite Cooking Liquor. *Tappi* 41, No. 3: 102–109 (March, 1958).

The corrosive properties of semichemical neutral sulphite liquors (I) toward mild steel were examined by means of weight-loss tests, potential-time curves, and polarization curves. The results of the experiments indicate that the major cause of steel corrosion in (I) is the reduction in pH that occurs during the cook. Negligible corrosion occurs above pH 10. Definite corrosion begins between pH 10 and 9.5 and increases in intensity as the pH decreases. The presence of thiosulphate and hydrosulphide ions further accelerates the corrosion rate at a liquor pH below 10. To reduce corrosion in lines and vessels handling (I), it is suggested that the pH of the liquor be kept as high as possible by adding the greatest permissible amount of sodium carbonate to the cooking liquor. The properties of polarization curves in the black liquor are outlined.

Kesler, R. B. A Bibliography of Alkaline Digester Corrosion; 1956–1957 Supplement. *Tappi* 41, No. 3: 170A–171A (March, 1958).

The supplement to the bibliography of alkaline digester corrosion includes annotated references from 1956 and 1957.

Nation, J. F., and Tull, J. M. How Lining with Inconel Combats Digester Corrosion. *Paper Ind.* 39, No. 1: 33, 36 (April, 1957).

During the last 5 years, 16 new digesters fabricated of steel clad with Inconel nickel-chromium alloy have gone into operation. In every case, these mills show either no corrosion or a corrosion rate very much lower than that of carbon steel and alloy steels in the same mill. Early experiments with Inconel-clad digesters, reasons for the superior protection afforded by the alloy, three cladding techniques, and results of some of the installations of Inconel-clad digesters are discussed.

Roald, B. The Effect of Steel Quality on Sulphate Digester Corrosion. *Norsk Skogind.* 11, No. 11: 446–450 (November, 1957). [In English; Norwegian summary.]

Steel specimens of 20 different compositions were exposed in two kraft-mill digesters. Test results confirmed the effect of silicon in increasing the digester-corrosion rate. A high nitrogen content rather than a high oxygen content may contribute to the low corrosion rates sometimes observed with low-silicon steels. Other constituents normally present in low-carbon steel, notably carbon, aluminum, and manganese, have no appreciable effect on the corrosion rate. The ability of steels to form calcite scales which afford excellent corrosion protection is apparently unrelated to steel composition.

Smith, C. W. Second Report—Regional Digester Activity. *Tappi* 40, No. 9: 728–729 (September, 1957).

TAPPI mill-report forms from 21 mills covering 162 digesters were examined. These data give corrosion rates considerably lower than those reported in the "First Report—Regional Digester Activity" [*Tappi* 39, No. 5: 340–342 (May, 1956)]. The average corrosion rates found in the current data correlate very closely with those reported in previous studies. This is attributed to better data and representation of most mills included in earlier surveys.

Richard B. Kesler, Research Aide, The Institute of Paper Chemistry Appleton, Wis.

Uusitalo, E. Electrochemical Studies of the Corrosion of Iron in Alkaline Monosulphide and Polysulphide Solutions. *Suomen Kemistilehti 29B*, 163–169 (1956). [In English.]

The behavior of iron toward sodium mono- and polysulphide solutions was studied by measuring the e.m.f. of the cells:

$$Fe|\text{satd. FeS, NaOH, } Na_2S\|\text{satd. KCl}|Hg_2Cl_2(S), Hg$$
$$Fe|\text{satd. FeS, NaOH, } Na_2S_x\|\text{satd. KCl}|Hg_2Cl_2(S), Hg$$

at 25°C. under various conditions. Corrosion is very marked in the monosulphide solutions, but much weaker in the polysulphide solutions, owing to the formation of a protective oxide layer. Iron can be made passive to the corrosive action of monosulphide by anodic oxidation. Satisfactory values for the sulphide-ion activity were obtained with both copper sulphide and silver sulphide reference electrodes. Only the silver sulphide electrode could be used for the polysulphide solutions.

Uusitalo, E. Corrosion of Steel in Alkaline Pulping Liquors. I. *Paperi ja Puu* 40, No. 8: 393–394, 396–397 (August, 1958). [In English; Finnish summary.]

Previous studies had shown that steel assumes a more negative electropotential, becomes active, and begins to corrode when immersed in alkaline monosulphide solutions. Steel can be maintained in, or returned to, the passive state by addition of polysulphide to the solution. Potential versus time and polarization curves indicate that the concentrations of sodium hydroxide (100 g.p.l.) and sodium monosulphide (35 g.p.l.) are sufficient to cause strong digester corrosion under unfavorable conditions. Apart from the addition of polysulphides (in amounts varying with the cooking conditions), corrosion can be prevented effectively by slightly decreasing the alkali concentration at the beginning of the cook. The decrease in sulphide content during the cooking process contributes very little to the reduction in the rate of corrosion. Anodic protection seems more promising than cathodic protection for preventing digester corrosion.

Wegerif, J. J. Alkaline Digester Corrosion. *Pulp Paper Mag. Can.* 59, No. 1: 104–108 (January, 1958).

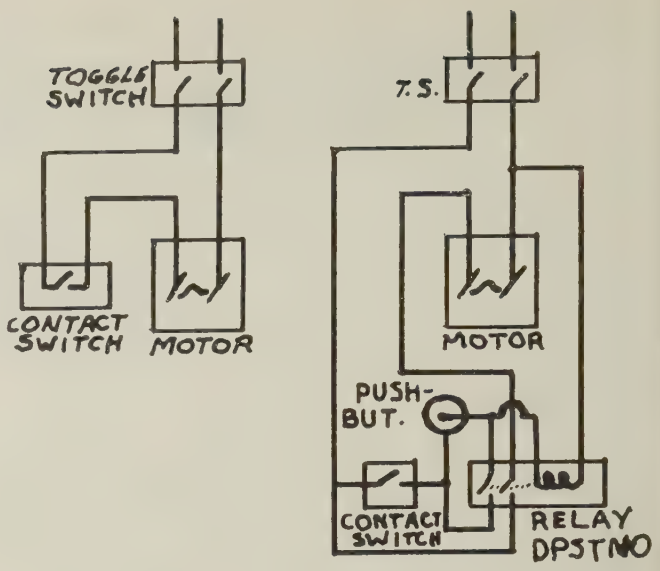
The author summarizes the experiences at the Harmac, B.C., Division of MacMillan & Bloedel Ltd., regarding the cause, repair, and prevention of digester corrosion. It has been established that digester corrosion is due largely to hot-plate boiling during charging of chips and liquor. The general corrosion patterns with a high and a low rate of knot charging are illustrated. With a high rate in an unlined digester, a zone of severe corrosion averaging 0.093 i.p.y. and a moderate zone averaging 0.057 in. are formed; with a low rate in a stainless-lined digester, the comparable figures for the two zones were 0.009 and 0.005 in. A strip-lining procedure is used to keep stainless-lined digesters serviceable. The application of corrosion-resistant materials to the affected areas has been adopted as one method for the prevention of corrosion.

LETTERS TO THE EDITOR

To the Editor, *Tappi*

This describes a modification of the M.I.T. fold test instrument which has been found easy to make and beneficial in use.

The instrument is constructed with a contact switch in the tension head which shuts it off when the sample breaks. Unless the main power switch is turned off during mounting of the next sample, the contact switch will reclose and start the instrument. If forgotten, this produces a considerable hazard of surprise and sometimes of barked knuckles. Operating the main switch requires an extra motion and is especially inconvenient when the manufacturer mounts it on the back of the motor as in recent new models (marked (1) in Fig. 2).



Present circuit M.I.T. fold tester — Modified circuit

Fig. 1

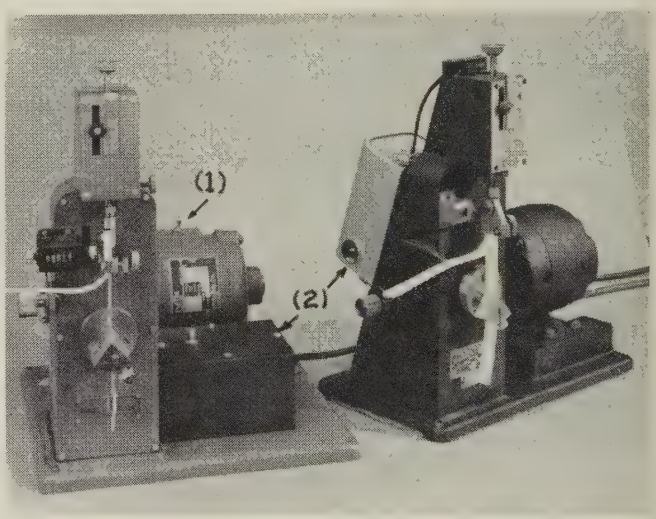


Fig. 2. New and old models M.I.T. fold tester
(1) Power switch location; (2) attachment with push button.

To correct this safety hazard and reduce the inconvenience, the attachment shown in the accompanying illustrations has been devised. Figure 1 shows the circuits of the original instrument and of the additions. Figure 2 shows the attachment, marked (2), on two models of the testing instrument.

In the modified circuit, the actual motor control is shifted from the contact switch to one pole of a double-pole, normally open relay. The contact switch and other relay pole act only as holding contacts for the relay. The motor therefore is not restarted by pulling down the tension head to mount the next sample. A conveniently located push-button contact is used to close the relay and start the test.

This attachment has proved its value in saving time and preventing hazard to the operator. It can easily be made up by any mill electrician; the relay can be of any common type and of low cost. Consideration of this change is also recommended to the manufacturer.

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Equipment for Extrusion Coating

J. E. NORDGREN and J. J. MELEAD

Machinery builders and plastic resin suppliers have often experienced receiving a communication from a paper converting manufacturer who wants to know about the process of extrusion coating a web with a plastic. The converter may be feeling the pressure of new extrusion coated products replacing his existing product line or he may be looking at the impressive growth pattern of this business as a cue to investigate this process. Often times he will have a good knowledge about the type of products he is planning to handle but is completely in the dark when it comes to the equipment required for extrusion coating.

It is the intent of this presentation to describe the equipment required for a successful extrusion coating machine line and to point out the reasons for design and application of the various elements in a machine. Perhaps it would be in order to explain the process of extrusion coating of a web. The process of extrusion itself involves the use of a plastic polymer in its raw or granual form which is fed into an extrusion machine where it is melted, mixed, and fed under pressure through a forming die. The plastic is in a molten state as it emerges from the die and is then cooled to retain the shape desired. In the case of extrusion coating, the die forms a film of plastic which is joined at a laminator section to a substrate or carrier web.

The following pieces of equipment are required for a basic extrusion coating machine line (as shown in Fig. 1): (1) an unwind stand for carrier web; (2) a coater or laminating machine; (3) an extruder with heating system, temperature control, and its own mechanical and electrical drive equipment; (4) a winder; and (5) mechanical and electrical drive to power the processing machine.

Following we will discuss the requisites of each piece of equipment as employed in a complete machine line and endeavor to point out the necessity and application of each type of equipment.

UNWIND

Because of the apparent problems in extrusion coating of heat stability, product uniformity, and the rather expensive materials being handled, it it essential that continuous operation be realized on an extrusion coating process. The continuous unwind equipment (Fig. 2) can take the form of two single position unwind stands or a double unwind stand with slide bearings, which will afford one running roll with a ready roll position for loading, or an alternate arrangement consisting of a rotating turret-type unwind with many modifications which would allow continuous unwinding with splicing on the fly and automatic cutoff of the tail.

Each of the afore mentioned systems has its own particular advantage depending upon web speeds and types of materials to be handled. Each application must be considered on its own merits and we do not believe that a flat statement can be made that any one system has the advantage over all others (*1*).

EXTRUSION COATER OR LAMINATOR

The extrusion coater or laminator is designed for combining an extruded film of hot melted plastic to a carrier web. This machine should be readily accessible to the operators from the feed-in side and the delivery side for web handling. The machine must be provided with adjustments to allow compensating for the technique and conditions employed in the extrusion coating process. (*2–9*).

The machine consists of the following elements (Fig. 3): a set of side frames or base supporting a chrome-plated cooling roll, against which a running nip is formed by a rubber-covered roller which is loaded through a pivot arm or a slideway, a lead-in idler with squaring adjustment roller to compensate for wrinkling tendencies in the web, a stripping idler roller positioned to lead the coated web with optimum wrap from the cooling drum, and other accessory or auxiliary items which may be necessary due to the type of material being coated.

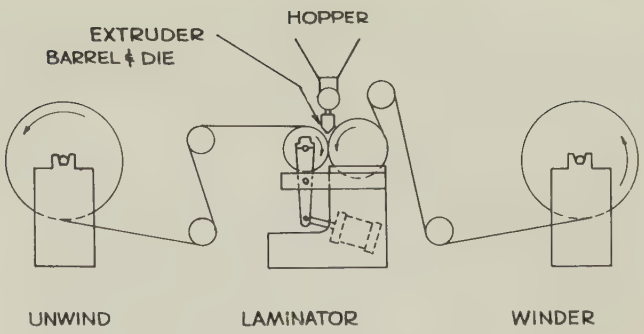

Fig. 1. Basic extrusion coating machine

Looking more closely at the laminator we wish to elaborate on the elements of its component parts (Fig. 4).

Cooling Roll

The cooling roll is the heart or most important part of the coating machine (*10*). When the plastic material emits from the die in its molten form, its temperature ranges from 400 to 600°F. and has to be cooled to a critical stripping temperature on the cooling roll face. The critical temperature is the point at which the combined coated web can readily be stripped from the cooling roll without signs of delamination. The surface characteristics of the cooling roll has a direct relationship in imparting the surface desired on the plastic coating. About three typical finishes are employed on the surface of the cooling roll, namely, bright mirror polish, 8 micro inch velvet grind, and various degrees of matte finish to impart a frosty texture to the coated web.

The drum is constructed with an inner and an outer shell of steel with the annular space partitioned with spiral flutes to give maximum cooling rate with minimum temperature variation across the face.

The shape of the spiral flute section between the inner and outer shell is designed to suit the cooling requirements of each application. In some instances the spiral flute is tapered with a varying pitch to give higher velocity of water flow at the exit end and somewhat compensate for temperature drop across the face.

The more recent installations provide a closed circulating system for the cooling water, using temperature control to

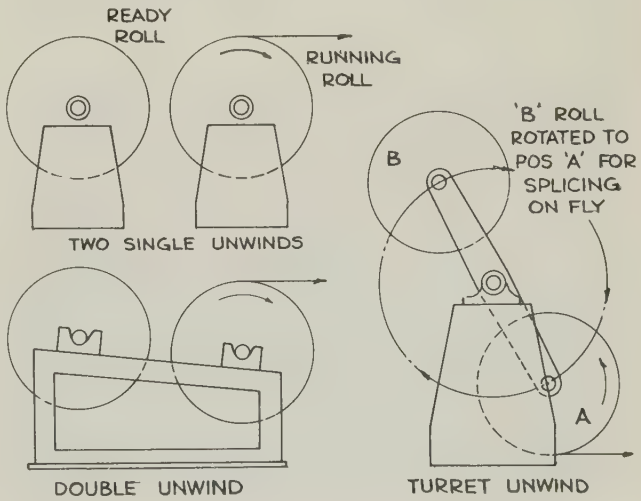

Fig. 2. Basic continuous unwinds

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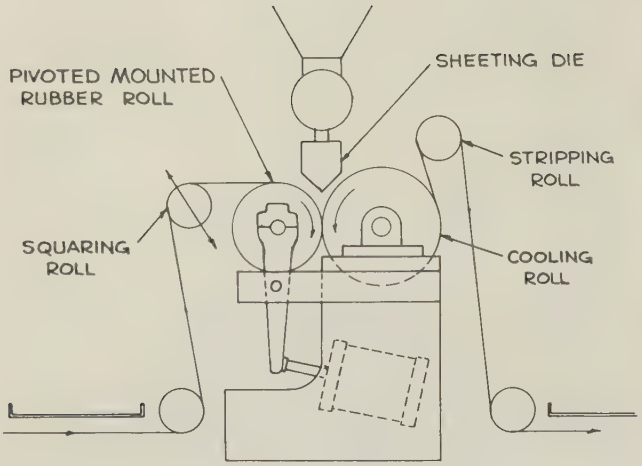

Fig. 3. Basic extrusion laminator

maintain drum surface cooling temperature. By this means a large volume of coolant can be circulated through the roll to keep the temperature drop across the face to a minimum. This also allows holding the drum surface temperature at an optimum for stripping and better lamination.

Pressure Roll

The actual combining or lamination of the plastic to the substrate is accomplished at the nip formed by the cooling roll as a backup and a rubber pressure roll which is loaded against it.

The relative position of the pressure roller to the opening of the die where the plastic emits can have effects on the finished product. These effects show up in the strength of the adhesion or bond between the substrate and coating. Under the section describing machine adjustments we will cover the position alternates for the pressure roll.

Mechanical design features to be included and considered on the pressure roll are as follows: Easily removable—this means the roll bearings should be mounted with split cap construction so that the roll can be removed and interchanged readily and quickly in the event of damage or for minimum loss of production. Type of covering—there is a need for heat resistance rubber covering with good release characteristics. Neoprene rubber of various densities has been applied in the range of 55 to 95 Shore A durometer. Silicone rubber cover compounds offer good release characteristics but to date cannot be procured in the complete range of hardness. Cooling of pressure roll—since the pressure roll is vulnerable to break down of the rubber compound from the heat, or delamination from the steel core, it is desirable to supplement the laminator cooling with a separate cooling means for

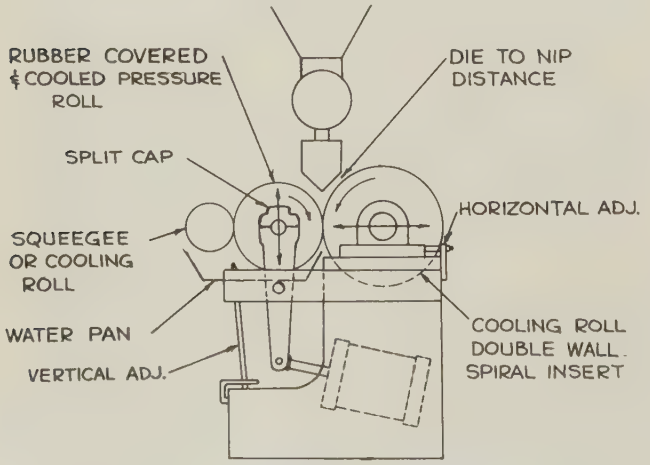

Fig. 4. Mechanical features of extrusion laminator

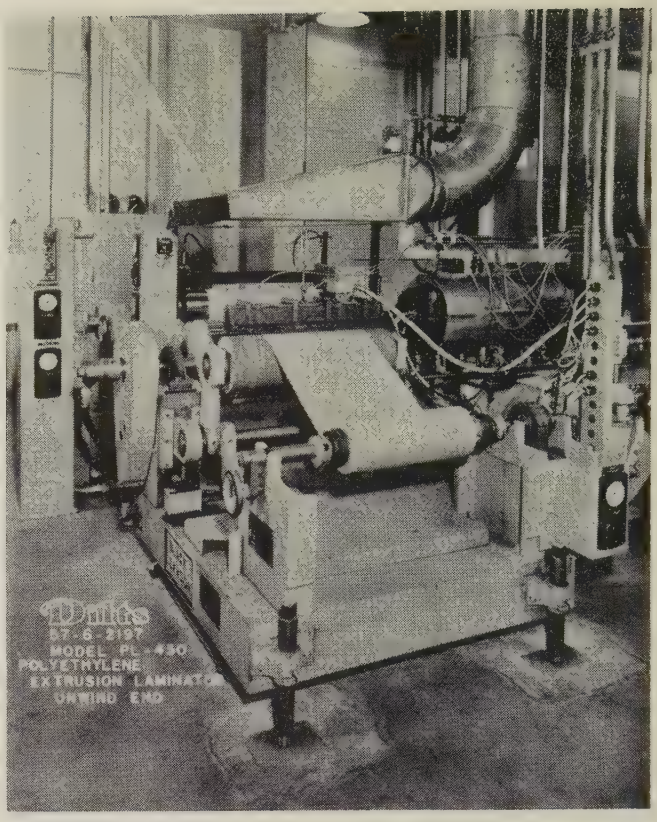

Fig. 5

the pressure roll. In most instances the core of the pressure roll is hollow and the journal bored so water can be circulated to provide internal cooling. External cooling of the pressure roll is accomplished with the addition of a water pan on the bottom side of the roll with circulating water and using a squeegee roll to remove the excess water, or a chrome-plated cooling roll running in contact with the pressure roller.

In the technique of extruding into the laminating nip it is desirable to extrude wider than the substrate in order to be be able to trim the edge bead from the film to end up with even calipered lamination. To accomplish this the early machines employed the method of under cutting the pressure roll to the width of the carrier web and extruding the plastic wider. Another way uses a Teflon pressure sensitive tape wound around the exposed end of the pressure roll in order to afford release of the plain plastic and effect better cooling by pressure contact of the trim to the cooling roll. Silicone rubber compounds currently being used are simpler by eliminating the need for the Teflon tape and undercutting. Each of the above has operating objections as follows:

Undercutting—requires a large stock of spare rolls.

Teflon tape—causes ridging in the rubber roll face when removed for a change to a different web width necessitating more frequent regrinding.

The silicone rolls—are limited to range of hardness, require internal cooling, and are fairly expensive.

Operating Adjustments and Controls

Conditions arise in the operation of a laminator which necessitates adjustments of machine elements (Fig. 4). The basic adjustment needed most is the vertical distance between the die orifice and the laminating nip. It is also desirous to have horizontal movement of the cooling roll to accomplish extruding onto the substrate before it reaches the combining nip or to the tangent point of the nip.

On a laboratory or pilot plant type of machine, the vertical die to nip adjustment has been accomplished by mounting the complete machine on a structure which operates vertically up and down through jackscrew arrangement (Fig. 5).

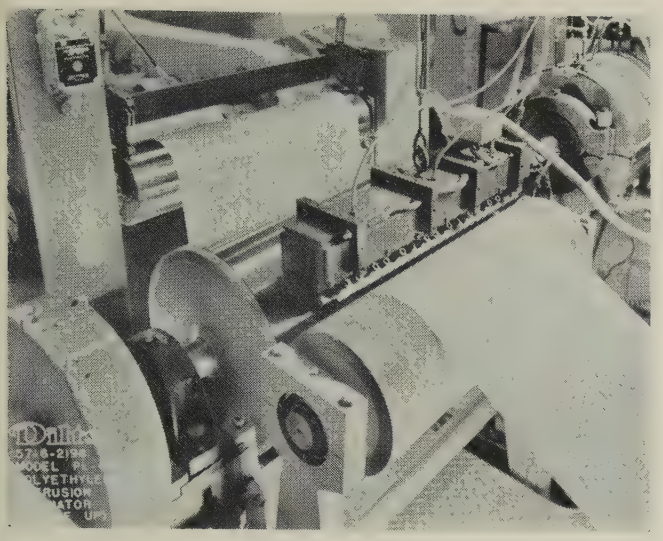

Fig. 6

This would allow a running adjustment for evaluation of adhesion effects due to draw distance. In the case of production equipment vertical die to nip distance is adjustable either by raising and lowering the extruder or in most instances raising and lowering the rubber roll assembly and providing a horizontal adjustment for the rubber roll and cooling roll.

The pressure roll should be provided with individual pressure loading system to each side so that nip pressure can be balanced across the face.

Early laminators used a feature of adjusting the stripping or wrap roll to allow variance of the amount of web contact with the cooling drum. On these machines the cooling drum temperature was held constant and relatively low and the wrap roll was used to control the amount of chill on the web. Recently it is found more desirable to use a fixed location for the wrap roll and to vary the temperature of the cooling water to control the drum temperature to give the stripping conditions desired. This also serves as adhesion control. Although not completely evaluated it has been found that overcooling of the web is generally more detrimental and produces excessive static than running the cooling roll at an optimum temperature. The position of the wrap roll is determined by the arrangement of the machine and the size of the cooling roll in combination with the output of the extruder and can be positioned as a setup adjustment with alternate locations.

Looking at the photograph (Fig. 6) it will be noted that the location of the sheeting die is nested close to the cooling drum and pressure roll. It is quite important to provide accessibility to both sides of the sheeting die by having a walkway on either side of the laminator section, to allow adjustment of the sizing jaw screws for gaging.

This walkway also serves as access to the slitters and will be helpful in threading of the machine.

Edge Trim Slitters

It is a rare case when trim slitting is not employed on an extrusion coating machine.

The type of trim slitters employed are shear cut, score cut, and razor blade slitting (*12*). The most popular method is the score cutting method. Equipment used for this method is a hardened platen backup roll against which a sharpened rotating knife wheel is run under pressure to penetrate through the material which is passing between the roller knife and the platen roll. The platen roll would be driven at the same speed as the web. This method is simple to set up and vary web width, easy to engage and disengage, makes good straight cut edges.

The shear cut method uses rotating scissors action wheels where the back shear acts as a support for the web and the front knife penetrates through the web and performs cutting action against the cup shape on the rear shear. The rear shear is driven.

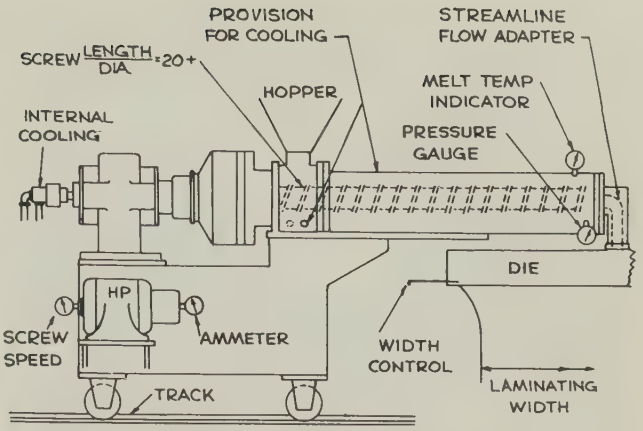

Fig. 7. Mechanical features for extruder

The razor blade or combination of razor blade and grooved roll uses a sharpened blade which bursts through the material for cutting.

Often times dual slitting methods are employed on a machine line. The purpose is to use the simplest method (score cut or razor blade) for removing uncontaminated plastic trim which can be reprocessed and salvaged and using a second shear cut slitter to trim a minimum of substrate and plastic for producing a good clean edge.

Extruder

The extruder (Fig. 7) handles the plastic material and prepares it for coating. Rather than talk about the extruder design, we feel it is more important to point out the requisites to be considered when applying an extruder for extrusion coating operation. These points are:

1. Extruder screw length (L) over the diameter (D) ratio should be a minimum of 20 to 1, to assure complete mixing and melting of resin.
2. The extruder should be sufficient capacity to handle a range of products and the production desired. The rated output should be checked against the temperature range at which the plastic is extruded. This has to do with the heater capacity furnished with the extruder as well as the screw speed, power on the extruder, and L/D ratio.
3. The screw of the extruder should be furnished with provision for internal cooling to be used at time of shutdown or during operation.
4. The barrel should have provision for external cooling.
5. For extrusion coating it is desirable to have the extruder mounted on track with casters so it can be retracted out of the machine line.
6. The electric drive or prime mover for the extruder

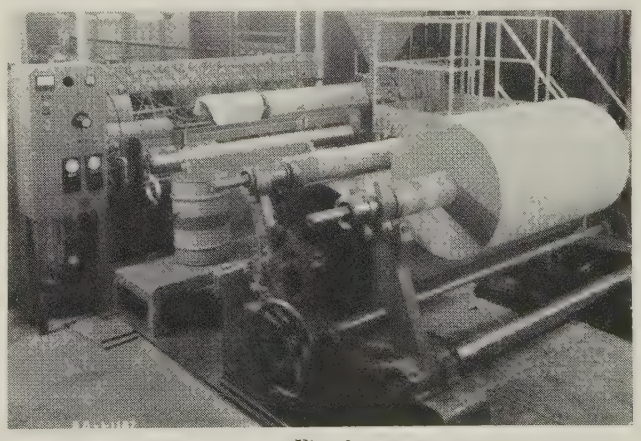

Fig. 8

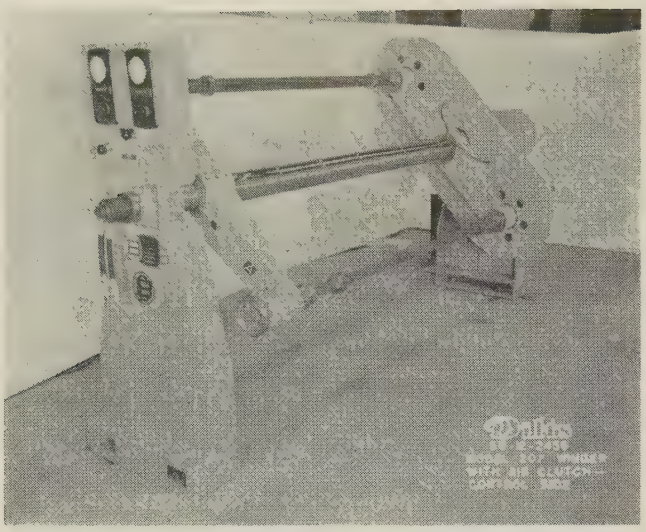

Fig. 9

should have a variable speed range, but once set, the operating screw speed should be maintained and be able to be repeated.

Operating controls which will be helpful in the extrusion coating operation on the extruder are as follows:

1. A screw speed indicator which will help the operator to know and repeat polymer output for the control of gage.
2. In addition to the temperature controls for the heating system of the extruder, a direct polymer melt temperature indication is helpful to show the material is at the desired temperature. This thermocouple should be located in the adapter or cavity at the end of the screw before the stock reaches the die adapter.
3. A pressure gage measuring the pressure in back of the breaker plate serves to indicate whether the polymer has a surging tendency.
4. In addition to the speed setting and speed indicating instruments on the electric drive for the extruder, it is helpful to have an ammeter to indicate the load on the drive. This is used on shutdowns and start-ups to prevent overloading and damage to the extruder, screen pack, or the mechanical and electrical drive components.

New and future developments to look for on the extruder are currently being evaluated and designed. Induction-type heating of the extruder and die will result in faster start-up time, more efficient operation, better temperature control, and longer life of the heating system due to elimination of failure of resistance heaters.

The newer extruder designs have incorporated features and working capacity for high pressure extrusion, in the range of 10,000 p.s.i. which will result in better quality and increased production. These machines have a unique system for controlling and varying the pressure while running.

The design of the sheeting die should contain these features:

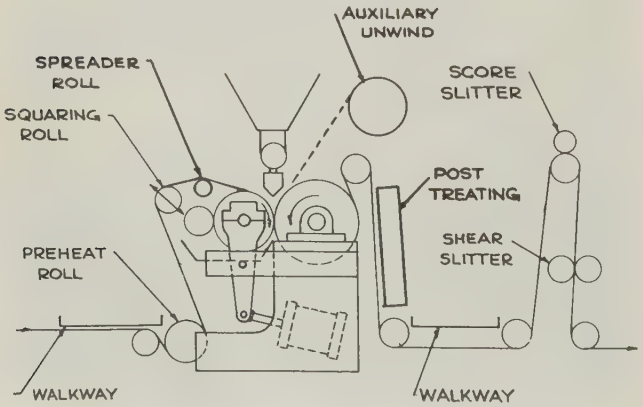

Fig. 10. Accessories for extrusion laminator

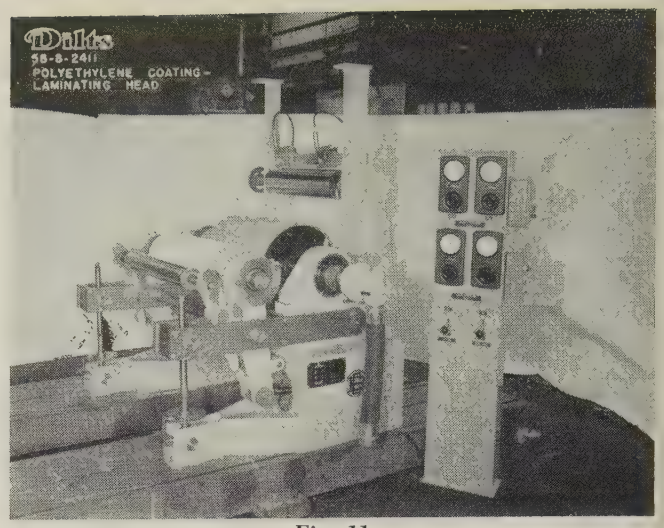

Fig. 11

(1) have a V shape for minimum draw distance, (2) streamline flow or the polymer, (3) produce uniform pressure across the width of the sizing jaw, (4) easily cleaned, (5) accurate gage control, (6) easy and accessible adjustment of gage, (7) long lands at the sizing jaws, (8) uniform control of temperature, and (9) adjustable width control with minimum leakage.

Winder

The winder, like the unwind, when applied to an extrusion coating process must have ability to operate continuously.

Two basic methods, either surface winding or center winding are successfully applied to continuous winding equipment. In the surface winding method the winding roll is supported on a drum which is driven. The web travels over the drum and to the nip formed by the winding roll and the drum (Fig. 8). Another arrangement uses two drums with the winding roll positioned in the saddle between the drums.

In center winding the driving power is transmitted to the core or center of the winding roll and exerts a torque on this core to pull the material from the laminating section and wind it into a roll (Fig. 9).

The method to be employed for the winder is determined by the type of material being coated. On heavy webs such as kraft paper or board the surface winder is well applied. The surface winder will handle a wider range of buildup, from the core to full roll size, and will generally produce a denser and tighter roll.

In the instance of light grades of paper, film, or foil the center wind method is preferred for the following reasons:

1. Tension in the web is readily varied through control of the drive source, and can be controlled giving constant tension through a wide range.
2. Caliper variations in the web have less effect by winding rolls of softer density.
3. Automatic cut and transfer mechanism for roll changes is readily adaptable.
4. Shaftless operation can be used by chucking the cores directly into spindles (*13*).

DRIVE EQUIPMENT

For successful extrusion coater operation an electric drive must have an 8:1 speed range, speed regulation to overcome varying load transients, and good speed indication for repeat of production conditions.

With a multimotor electric drive, speed regulation and good draw control are desirable. If a single motor with a line shaft drive is provided, mechanical draw control features should be incorporated between various machine sections.

Speed regulation to overcome varying load transients is required to avoid variation in coating weights.

Once heat balance is obtained in the extruder, the output of the extruder or screw speed should not be altered radically. However, the coating thickness (caliper weight) can be varied as desired by changing the speed of the web with the variable speed drive. Thus the coating thickness is directly related to the extruder output rate and web speed.

As an example, it is known that approximately 15 lb. of polyethylene covers 1 ream of 3000 sq. ft. with 1 mil poly thickness. Thus to cover a 72-in web running at 150 f.p.m. with 1 mil thickness of polyethylene will require 270 lb. per hr. output of the extruder. It is possible to run a half mil thickness by increasing the speed from 150 to 300 f.p.m. However, when running at 300 f.p.m. if a 1 mil thickness is required 540 lb. per hr. output would be required of the extruder.

The location of auxiliary sections becomes a designer's problem if accessibility and good web flow are to be maintained. Trim slitting which has been discussed previously must be located with thought to the trim removal system while retaining accessibility to both the laminator and the slitters.

Below are mentioned other auxiliary sections or items used to augment the extrusion laminator (Fig. 10).

1. Preheating equipment is required where an operator is handling comparatively moist grades of paper, board, or glassine. Heating can be accomplished with a hot roll, direct flame burners or electrical radiant heaters to condition the web for improvement of adhesion. Such units would be located ahead of the combining nip.

2. Web wrinkling conditions can be eliminated by the use of a spreader roll, slat expander, or arched bow bar where web has a tendency for slack edges or unevenness across its width. This unit would be located immediately ahead of the pressure roll in the laminator where good web laydown is desired.

3. An auxiliary unwind for three-ply (sandwich) lamination has been included in machine lines and is usually located in the area above the stripping roller with web fed into the laminating nip.

4. Post heating of the plastic coated web is occasionally desired to improve adhesion, printability, and promote clarity of the web. These may be the same as the preheat unit although the flame type is usually preferred.

5. Web alignment through the laminating operation is taken care of adequately at the unwind stand when the unwinding rolls are fairly square and the web has good tracking characteristics. However, automatic edge guiding can be provided at the unwind and also at various points in the process line as required.

6. Treatment of the web is sometimes incorporated in the machine line to apply a coating which will promote adhesion to grades such as film and foil. The coatings used are usually of the solvent type and require drying equipment of explosion-proof design.

7. Printing equipment in line with extrusion laminating has been in operation for some time. It can be readily understood with the addition of more processing equipment within the same machine line, not only must the processing equipment be designed specifically for the application but the operators must be highly skilled and quality control becomes important to production and yield of the machine.

A general discussion could ensue as to the practicability of having one machine line incorporate all of the equipment

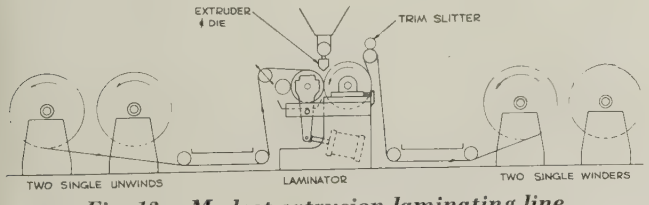

Fig. 12. Modest extrusion laminating line

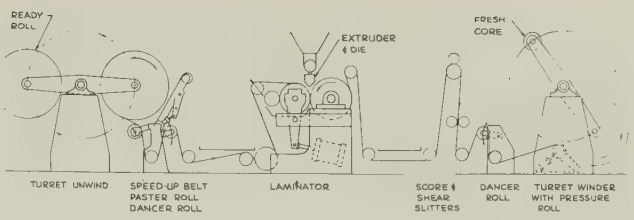

Fig. 13. Extrusion laminating line featuring continuous operation

described above and other items as they are developed but it must be remembered these auxiliary items should be compatible to the extrusion coating operation. We have on occasion been requested to have the extruder applicable not only for extrusion coating but for free film, blown tube, shapes, and other extrusion operations off of the same line. As machinery manufacturers, we can build the machinery to do all these operations in line but it is our experience that there is a practical limit. The expense of the equipment rises, so in the long run, one machine to do a reasonable amount of operation and a second less expensive machine line would be more practical when considering part of the equipment would be idle at one time or another.

There is very little difference between a modest extrusion laminating machine line and a laminating machine line featuring continuous operation when viewing the laminator section alone (Fig. 11). Accessories to the laminating section, as have been previously discussed, would be added in the web lead into or out of this section.

Basic considerations for a modest machine would be at the unwind and winder which would be operated manually to accomplish splicing (Fig. 12). The more elaborate machine line would feature continuous operation with means for constant tension control and the ability to splice at the unwind and roll change automatically at the winder. The arrangement of equipment as illustrated on Fig. 13 shows an idealistic web flow featuring continuous operation.

As we have pointed out in this paper there are many variables to be considered when choosing a correct line of equipment for a company's requirements. We hope the subjects as we discussed will be of assistance to you, not only in the selection of new equipment lines which you may consider but for upgrading of existing lines for making your production more profitable.

Extrusion laminating has blossomed within the last few years into big business. The future will certainly prove that the plastic industry and extrusion coating will play a greater part in the converter's business.

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A Hardwood Neutral Sulphite Pulp Mill

R. H. TAYLOR and N. G. McLEAN

THIS paper will describe in general terms the planning, choice of units, construction, and start-up of a 70-ton-per-day neutral sulphite pulp mill intended primarily for operation on mixed northern hardwoods.

Before getting into this discussion, please let us express again our appreciation to the people in the industry who were very helpful in giving us advice and results of operation experiences that were invaluable. And all of us in the neutral sulphite field must thank the Forest Products Laboratory at Madison, Wis., for its early pioneering work with this process.

Building the mill was a great experience in the cooperative attitude that prevails in the paper industry in America. We were given hundreds of man hours of consultation time and advice worth hundreds of thousands of dollars. If we can repay a little of that by sharing our limited information, we are glad to do so.

After World War II it became evident that our company could no longer remain competitive in manufacturing newsprint which had been its chief product up to that time. For 6 or 7 years modernization and extension of the paper mill and the groundwood mill carried the business forward in the groundwood specialty paper field. It then appeared that future development would require increased integrated pulping capacity. Purchased sulphite and kraft pulps had always been used to supplement the mill's own groundwood.

An increase in softwood groundwood was not feasible because of the limited supply of suitable pulpwood within an economical hauling distance of the mill. Naturally, the various processes then under development or in pilot plant stages for the production of chemigroundwood, groundwood from chips, or semichemical replacements for groundwood were studied. Nearly all of these processes had been, or were being, adopted by other people who faced essentially the same problem that we did: the shortage of suitable softwood for conventional groundwood and a supply of hardwoods which previously had not been considered adaptable to printing paper manufacture.

We decided that none of the hardwood pulps which were essentially softwood groundwood substitutes would do the job of upgrading our papers which we wished to accomplish. Our groundwood mill was up to date and economical to operate on limited but assured supplies of softwood from the company's own timberlands. We had two bleaching plants for groundwood in which we could peroxide bleach to good brightness levels. The cleanliness of the groundwood was good after the installation of enough Bauer Centri-Cleaners to handle the entire tonnage of the pulp mill. This groundwood produced excellent papers for printing purposes—reasonably bright, clean, high opacity, excellent ink receptivity, and economical. What pulp could we choose to supplement these qualities best? Some of the qualities for which we were searching were: improved strength factors—burst, tensile, tear, and fold; increased brightness; greater resistance to linting; and better handle or character.

Naturally, we turned to the old reliable kraft and acid sulphite processes to consider their adaptability to our requirements. Acid sulphite was easy to discard from a chemical cost and stream pollution standpoint. Further, it did not produce the best type of pulp to fit our needs. The latter factor led us to drop consideration of some of the more recently developed sulphite processes which include the possibilities of chemical recovery.

Kraft pulp, economical because of chemical recovery which at the same time removes the stream pollution objection, offered many of the papermaking qualities for which we were looking. This process certainly had to be given very serious study.

Although neutral sulphite was definitely not a new process—you will remember that it was developed at the Forest Products Laboratory in the middle twenties—it had not received wide acceptance as a process for manufacturing bleached pulps at the time that we were investigating. Rather reluctantly we began to consider its possible application to our job. It was quickly apparent that the neutral sulphite process would produce from our locality's hardwood a pulp of greater strength than any other available commercial process. Its brightness possibilities and sheet-forming characteristics were plus factors.

A very important public relations factor in pulp mill construction in an established community is odor. Since Glens Falls is over one hundred years old and has diversified industrial concerns, it cannot be classified as a "paper mill" town. Our neighbors would not have approved the classic kraft odor. Odor masking apparently would not be thorough enough to overcome the objections. Neutral sulphite has a very slight, unobjectionable odor.

Our decision then had to be neutral sulphite. We would not choose otherwise today.

As we convassed the industry it appeared that the few plants which were making, or starting to make, bleached neutral sulphite pulp were bleaching this pulp with a conventional three-stage bleaching process. A chlorination stage was followed by caustic extraction and then by hypochlorite bleach. We decided to follow this pattern.

Since bleached neutral sulphite pulp was not widely produced when we were conducting our studies (in 1955), guidance in choosing some of the major items of equipment was not so readily available as it is today. We knew of only three companies producing this pulp on a commercial scale. We have since learned of two others who were then in operation and two more got into production ahead of us.

In digesters we were offered a choice of.

1. A standard tile-lined mild steel shell similar to the digesters used in acid sulphite. Several of these had been changed over to the neutral sulphite process, but apparently no new units had been constructed. Since we had no chemical pulp mill equipment, we did not consider such a digester.

2. Rotary digesters were used by two of the companies which we had heard about. Good circulation was mentioned as a reason for their selection. We felt that maintenance problems and chip handling problems inherent in this type of unit outweighed the good features.

3. A standard mild steel digester clad inside with stainless steel. This is the unit that we chose.

4. Various continuous digesters of types with which you fellows in the southern mills are much more familiar than we. As you know there are many of these units in operation producing unbleached neutral sulphite for boxboard, corrugating, and other similar grades. We did not select one because we were uncertain about the bleachability of the pulp. The mechanical maintenance problems of a digester large enough to give us the type of cook which we felt would be necessary also influenced our thinking in turning down these digesters. We have learned of the installation of a continuous digester on bleached neutral sulphite in Japan—it is an American digester, but we don't have much information on its operation.

5. We gave a lot of thought to the Kamyr type of continuous digester. It appeared to have many desirable features. We would have had a much harder decision to make regarding this digester if our plant had been designed for 150 tons or more. At half that capacity the Kamyr design appeared to be too high in initial cost compared to the standard batch digester that we bought.

In refiners we never seriously considered anything other than the 800-hp. double disk units which we installed.

R. H. TAYLOR and N. G. McLEAN, Finch, Pruyn & Co. Glens Falls, N. Y.

We did not have to learn about plate patterns through bitter experience because many other operators gave us good advice on which to base our initial selection.

We decided on a blow tank with bottom agitation, high density storage in the top part, and controlled dilution to the lower zone. This is not new for high density storage for those in the kraft mills, but we had heard of only one mill handling chips-in-liquor in this fashion. To us it was a risky decision because we had heard how rapidly the mixture of cooked chips and neutral sulphite spent liquor can set up into hardboard.

We took the risk of trying to handle the chips and liquor together for several reasons. First, it avoided the mechanical maintenance problems that accompany screw conveyors. Second, in keeping the chips in the hot liquor for a longer period we retain more heat for the refining operation. Finally, the initial cost of the installation was less than equivalent live bottom bins and conveyors and allowed a simpler over-all mill design.

Mill housekeeping has been easier because of this method of cooked chip handling.

For the same reasons we chose to pump liquor and chips in a circulating pipe loop out of the blow tank and back into it. We feed the refiners with star feeders drawing off this circulating loop.

There is some cooling of the chips by the spent liquor which is introduced at the bottom of the blow tank for dilution before circulation. Additional cooling comes when we screen off some of the liquor from the chips ahead of the refiners.

In screening we did something new. Lots of people had warned us about the limitations on washer capacity which slow-draining neutral sulphite pulp brought on. The washer manufacturers were ultraconservative in leaf-test reports and their washer size recommendations. Since the washers were to be a major factor in controlling the eventual capacity of the plant, we wanted to give them every break possible. We knew that entrained air and foam in the brown stock would cut down washer capacity. We set out to avoid air entrainment and conditions that would lead to foam. We felt that an open screen exposed the stock to the air about as badly as any piece of equipment could. Therefore, our choice was the only pressurized screen that was commercially available at the time. This screen was not a sharp screen in separation. Its principal use had been as a protective screen ahead of paper machines. The basket selected had the smallest sized hole readily available. This choice was made to do the best shive removal job that we could with this screen.

The screens have been very satisfactory in keeping down foam and avoiding air entrainment. In the beginning we were disappointed in shive removal. We have since increased the continuous rejection rate from the screens. The manufacturer has supplied baskets with smaller hole diameters than the originals. These changes have made the screening acceptable. We have had some trouble with basket breakage, but several corrective measures are underway. Over-all we are satisfied with the screens in their new application.

As a side light, we didn't have full confidence in the foam reducing character of our system so we installed a foam breaker on one of the brown stock washer seal tanks. That is the least used piece of equipment in the mill.

Other major equipment in the mill is in the bleach plant which was conventional. It did not entail the selection problems that we encountered in the pulping section. We did decide to install our Bauer cleaners almost at the end of the process. The stock from the hypo tower is diluted to low consistency and passed through the cleaners on its way to the washer.

We are not sure that this is the most effective place to install the Bauer cleaners. There are many people who believe that they should be put on the brown stock. We get good cleaning, but we might match it with cleaners on the brown stock. Shive reworking is easier when the cleaners are put on the brown stock. Obviously, extraneous dirt in the bleaching system would not be removed if the cleaners were on the brown stock.

Going back on equipment selection we picked up the West Coast idea of blowing chips and applied it in the cold North country. We had some misgivings about the possibility of freeze ups in the chip pipeline, but last winter we had no serious trouble. Our barking drum and chipper unit is located several hundred feet from the pulp mill. A feeder unit under the chip screens drops the chips into the pipe. A blower supplies the high velocity air which conveys the chips to a silo close to the digester.

One of the things that was impressed upon us by almost everybody who had done any work with neutral sulphite pulping was the corrosive nature of the spent liquor even though its pH did not indicate high corrosion potentials. We adopted 316 ELC stainless for everything that touched the liquor in our pulping operation. Perhaps some few items were overly expensive because of this decision, but the year's operation has procured no corrosion problems in this section of the mill.

In August, 1957, Robert Collins of Crossett Paper Mills wrote an article for one of the paper magazines covering the operating conditions which they had settled on after a year's operation of their bleached neutral sulphite mill. We almost used that article as an operating manual in starting up our operation. Since his data were based on a mill pulping oak and gum woods and we are pulping birch, beech, and maple, there have obviously been a few places where we have varied out procedures. But they aren't wide enough variations to take your time discussing them. This paper will not include operating data because Mr. Collins did such a thorough job. It would simply be repetition to give our results.

It is fortunate that Mother Nature provides us with a sense of humor. And it is particularly fortunate for us in the paper industry that time adds humor to once trying situations instead of bitterness. The fact that our roughly 10,000-cu. ft. capacity blow tank swayed about a foot at the top on some of our first blows from the digester now makes me think of the rear end of an elephant doing a hula as they do in a circus. But the first time I walked out on the platform from our washer level floor and saw the top of that tank sway, the feeling I had wasn't humorous. Since our start-up was a year ago, maybe we can add some humor to the troubles and at the same time help some of you avoid some of the difficulties we had. Goodness knows, you will have enough different ones of your own.

To satisfy your curiosity we cured the blow tank sway troubles by doing three things: (1) reducing the angle of the blades on the agitator, (2) reducing the speed of the agitator, and (3) relocating and adding to the sway bracing on the columns that support the tank.

Part of this trouble also stemmed from lack of control of the dilution water at the bottom of the blow tank. This, in turn, fell back on several problems of water supply, but chiefly it was caused by our troubles with a flow ratio control system of dilution control. We had attempted to ratio dilution water flow into the blow tank to the stock flow out of the refined stock chest to the washers. This would maintain a constant amount of material in the refiner loop. In practice the lag in the system was too great and stock consistency control at the refiners too uncertain to permit effective operation.

We finally turned to the old standby of a measurement of the current demanded by the agitator motor at the base of the blow tank. This has worked satisfactorily. Before the mill started we were sure that the presence of chips in

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the liquor would cause trouble with this method of measurement.

The major source of start-up trouble for us came from plugging the chip circulating pipe. As you will recall, a pump takes liquor and chips from the blow tank and circulates them through a pipe from which the refiner feeders draw and then returns the excess chips and liquor to the blow tank again. Several times it took us two shifts to unplug this circulating line. We had particularly bad troubles the first time that we tried to operate the refiners continuously. These latter troubles were entirely due to the fact that the refiner feeders, which are essentially heavy duty star feeders, were mounted several feet from the tee on the circulating pipe. The sections of pipe between the circulating line and the feeders plugged solid several times. We moved the feeders right up against the circulating pipe and haven't had a minute's trouble since. This solution was not original with us; the Weyerhaeuser people in Washington had similar troubles with their system which was similar to ours. They were kind enough to give us the answer by telephone the morning after our first hard night on the start-up.

Everybody seems to have troubles with chlorine when they first start to use it, but we had more than our share. In general, we had no trouble with the welded pipe used almost universally throughout our mill. Not the chlorine pipe though! The guy that welded the supply pipe to our chlorine vaporizing room must have been recovering from a lost weekend. We finally stopped patching his welds and replaced the pipe. We didn't become that smart until we had had to issue a rush order for replacement sets of cannisters for our gas masks. Be sure to test your chlorine lines thoroughly with air pressure left on at least a day is our advice for avoiding this trouble.

We bought several valves for the chlorine system in the first week or two. Each valve failure brought off another alarm for escaping gas. We finally discovered that the chlorine blowoff line and the steam trap blowoff emptied into the same vent. Each time we blew a safety plug in the chlorine vaporizer, water from the condensing steam would run down the pipe into the vaporizer. Hydrochloric acid is corrosive; we had proof positive in the valves and pipes of the chlorine system.

One of the most serious of our troubles came from the washer droplegs. Somebody dropped them down about 3 in. below the top of the seal boxes, but forgot about taking them below the liquid level in the seal box. A vacuum washer without vacuum is a pretty helpless thing.

After about a month of fairly smooth digester operation we began to have hangups when we blew. As neophytes we developed all kinds of theories about our cooks, about lack of penetration of cooking liquor into the chips and about digester circulation. We did have digester circulation problems and they may have been the major source of this trouble. To prevent chips in the digester from backing up into the lower liquor supply ring we had installed screens over the outlets from this ring into the digester. The openings in these screens were smaller than the openings in the screen in the center ring from which we drew off digester liquor for the heat exchanger. Consequently, many of the chips which were small enough to get into the liquor circulating system through the center screen were large enough to plug the openings in the screens in the digester returns.

We had been purchasing some of our chips from a sawmill; they had suddenly decided that the end blocks cut from sheir dimension lumber would make as good chips as the slabs. The blocks would have been all right except that they went through the chipper practically unbroken as to length. Some of these stocks started some real jamups in our blow line. And in the chip circulating pipe, too, when they got over to the blow tank and into the chip circulating pipe.

We are back to that chip circulating pipe again. In addition to those long end-block sticks the blow tank dilution troubles undoubtedly played a big part in causing some of our plug-ups. When those chips and that liquor hardened in the pipe after being packed by the circulating pump, we really had a tough material to clean out of a pipe. We heartily recommend chipboard made from practically these same materials because it's really tough—don't let it near your pipes, though!

The thickening screens ahead of the refiners were a major source of trouble. We took the liquor that drained through these screens back to the spent liquor storage tank and used it to make up volume in digester filling. Unfortunately, the screens were not well sealed and allowed some chips to go along with the liquor to the spent liquor storage. When these chips finally reached the spent liquor measuring tank they started to settle out. They ended up lugging the digester liquor charging pump which really put us out of commission. The chips also collected in the spent liquor storage tanks and gave us some real cleanup problems. They also plugged our spent liquor heat exchanger which helped to heat washer shower water. We rebuilt the thickening screens to control the flow of chips into the refiners instead of into the liquor discharge.

The story of our troubles wouldn't be complete without recalling that all kinds of things kept happening to the latch openers for our elevator doors. They didn't arrive until a week or so after the start-up. We could not use the elevator. We never did settle the question of whether there were 98 or 99 steps from the basement to the washer floor! We did decide that 13 round trips a day up and down those stairs was about par for the course.

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